# AGRICULTURAL ENGINEERING

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# *Animal Nutrition*

FEED GRINDING is a preparation-for-digestion process based on a generalization as to the economy of substituting low-cost mechanical or electrical energy for high-cost animal energy in meeting a part of digestion energy requirements. Its full possibilities in terms of mechanical condition of feeds for optimum animal nutrition for meat, milk, eggs, wool, or power production, or other use, have not yet been developed.

Pioneering work has been done in plant production with nutrient solutions and controlled environment to make the most of inherent biological potentialities for yield and quality of leaf, stem, flower, fruit, tuber, or root. This incites conjecture as to what optimum nutrition might be for various classes, types, and breeds of farm livestock, how much it might influence yield and quality of production, and what its effects might be on practical farm operation.

Determining the nutritional and environmental optimums is a problem, or group of problems, in biological science. Determining how these may be realized in practical operation, by the application of power, materials, machines, and controls is agricultural engineering. Agreement on mutually satisfactory measures of the physical condition of feeds, and of environmental control, is a field for cooperation between biologic scientists and agricultural engineers.

# AGRICULTURAL ENGINEERING

VOL 19, NO 12 EDITORIALS DECEMBER 1938


## Purchasing Power Prices

"WE HAVE recently been going through the throes of an 'agricultural adjustment' struggle of large dimensions. But adjustment to what? In fact, I think the answer must regretfully be given, adjustment of an able and willing agricultural industry down to an unsatisfactory standard of consumption for the nation's people as a whole. If all American consumers had a technically satisfactory food budget, the problem of agricultural adjustment would disappear for practically every type of farming except cotton, and it would be enormously simplified, even there."[1]

The author of this statement is Dr. Edwin G. Nourse, well-known economist, who in discussing the relationship between purchasing power and food consumption continues in part, relative to a modern trend in pricing, "The distinctive feature of this constructive attack on the problem of pricing is that, instead of starting from the position in which the administrator and the technique happen to be, and moving forward by cumulative cost computation to set a price, it starts from the consumers want and purchasing power and courageously accepts the task of finding a means of satisfying these wants within the limitations of this purchasing power."

This recognition of the potential domestic food market, of the serious constrictions which high food prices and low buying power place upon consumers and on the farm produce market, and of the possibility of technological progress in improving production processes, is in line, we believe, with the thinking of many agricultural engineers. It is a challenge to agricultural engineers to be thinking and working more than ever before, toward helping farmers lower their production and marketing costs to a point which will enable them to enjoy a profit at prices which will enable the American public to enjoy proper nutrition.

[1]"The Economic Problem of Nutrition," by Edwin G. Nourse, Journal of Home Economics, October, 1938.

## Engineers as Citizens

THE public needs only a chance to get better acquainted with engineers, we believe, to recognize them as good average human beings—good neighbors and citizens with a genuine interest in the welfare of their fellow men, some practical ideas on how that welfare may be advanced, and an uncommon sense of honesty, integrity, and fairness in all human relations.

From increased contact with engineers the public might also gain a clearer understanding that engineers are not magicians but patient, cautious, cooperative, constructive workers with facts; schooled in the rigid discipline of science; progressive and idealistic in outlook; realistic as to methods and possibilities; stable under the stress of emotional propaganda for revolutionary change, but responsive to the need of evolutionary development.

American Engineering Council and the various engineering societies are taking desirable steps to better acquaint the public with engineers. But the public is a large body, and difficult to reach with serious, unemotional matters beyond the contacts of its individual daily lives. The desirable qualities by which engineers might well be known rarely exhibit themselves in the dramatic, spectacular ways which newspapers delight in broadcasting as human interest stories.

Progress in acquainting the public with engineers will necessarily be slow. In the meantime individual engineers will do well to live up, to the best of their ability, to their own high estimate of their calling.

## Agricultural Gold Bricks

GOLD BRICKS are now available in assorted ultra-modern combinations of pseudoscientific and pastoral motif.

In spite of the predictions and warnings of those who have led the serious and unselfish search for new farm crops and new uses for existing farm products, the new style of gold brick is establishing a sales record higher than that of the Brooklyn Bridge.

Farmers and would-be farmers who will act fast—before the sheriff has a chance to catch up with the promoter—are being presented chances to invest in various ventures ranging from overrated and overpriced seed and breeding stock to worthless oysterbeds.

Agricultural engineers, in their numerous contacts with farmers, farming projects, business men, and scientific progress, have an excellent opportunity to broadcast incidental warnings against snap-judgment betting on the word of any promoter that some particular agricultural project is a sure winner. Such warnings might well include the information that the services of better business bureaus are available without cost, to check the record and methods of the promoter; that the agricultural colleges and U. S. Department of Agriculture can suggest considerations involved in determining the feasibility of a new agricultural project; and that a good way to distinguish between rackets and legitimate schemes is to call in legal counsel before taking any action. The unscrupulous promoter may often be identified by one or more unconventional ways of doing business; by his haste and anxiety to let the prospect in on some special opportunity before it is too late; by his encouragement of secrecy; or by his assurance that the prospect can't lose on the deal.

Desire for easy money is common in human nature, and legitimate. Honestly and wisely directed, it has stimulated progress. The practice of seeking it by preying on the same desire in other people is not legitimate, and is a needless tax on legitimate business that agricultural engineers can help minimize, particularly in the case of agricultural variations of the gilded brick.

# Research Viewpoints

AT THE request of E. A. Silver, chairman of the A.S.A.E. Committee on Research, AGRICULTURAL ENGINEERING offers here a miscellany of comments on research by agricultural engineers and by various leaders of research in other fields of science and engineering. The object is to stimulate thought and an exchange of viewpoints on the nature, methods, and objectives—the mental technique—of research in agricultural engineering.

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"It seems to me that in the past research has been considered more or less as a side issue in agricultural engineering. In other words, we have paid probably a little bit too much attention to research results and not enough to research viewpoint. I feel that in order for research to improve, the research workers themselves must be given an opportunity to improve their viewpoint on this all-important phase or field of activity. In other words, we must have research of research."—E. A. Silver, in correspondence, October 1938.

* * *

"In my industry, which happens to be a branch of the electrical industry, we came, about thirty years ago, to the point where the recovery of further values from science, which we knew to exist, could no longer be obtained by men, however skillful, whose training was limited to that of the engineering schools of the day. In a word, the man who knew the facts of science as they existed at that time, and who was competent to apply what he knew, but who knew very little if anything about the fundamentals of science itself, found himself impotent in the electrical field to produce the advances which were obviously potentially at hand. In our particular industry it became evident quite rapidly that we had to introduce men of a different type of training if we were going to continue to progress. Added to this appreciation was the further fact that about that time the basic sciences themselves (physics, chemistry, and the other fundamental sciences) were experiencing an enormous growth. Thanks to the work of the men in the scientific laboratories of universities and technical schools, our store of basic knowledge was being daily augmented by a great array of new and as yet unapplied material. Most of this material was a terra incognita to the men then actively in the electrical industry."—The Place of Research in Industry, by F. B. Jewett, Bell Telephone Laboratories, March 1932.

Dr. Jewett pictures here, as we see it, an industry which lost, and later regained, effective contact with the sciences on which it is based. It exhausted the practical applications in its field, of the physics and chemistry which its research engineers learned when they were in school. It got back into the path of technological and commercial progress by introducing into its research setup men who were up-to-date in the sciences upon which it was based—men qualified by training in research viewpoint and basic science to dig deeper into technical possibilities related to its commercial and service objectives.

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"*Practice.* If we make a painstaking survey of current engineering practice, we are forced to admit that it lags way behind the knowledge which has been developed from research and scientific analysis. This applies generally throughout the entire field. Examples occur in the road field, in the structural field, and in many others. Building codes, for example, frequently prescribe narrow limits, within which the practitioner must prepare his designs, and yet many building codes are obsolete in the light of present-day knowledge."

"*Research.* As we approach the problem of interpreting and selling the fruits of research to the practitioner, it might be well to pause and consider what is research. To my mind, it may be best defined as the honest, intelligent, painstaking search for useful truth. As such, it exists for the good it produces; and any activity carried on as mental gymnastics, for entertainment and pleasure alone, or for the personal aggrandizement of individuals, does not come within this definition, and cannot be dignified by the name research. In its higher sense, research is a sacred trust. It must be entrusted to those high-minded, self-sacrificing, conscientious individuals who will regard it as such, and who will realize their responsibility to their fellow members of the engineering profession."—Frank T. Sheets in the Journal of the American Concrete Institute, May-June 1938.

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"The function of a laboratory organization is to secure a broad, well-ordered, and self-extending knowledge of the art with which it is concerned and to make this knowledge available for translation into superior industrial performance. . . .

"Some of the laboratory's tasks will be those of immediate application; others will have to do with more distant and often unforseeable changes. We may for convenience designate these two functions as engineering and research. . . . The desired distinction is one of immediacy of application.

"Used in this sense, engineering and research comprise the work of any laboratory. There is much to be said in favor of combining these functions in each of the several units of organization. Research stimulates the imagination of the engineer and insures the incorporation in his work of unconventional ideas if they happen to be readily applicable. It spurs him to inquire about fundamental objectives and to examine his projects more critically. Engineering has an equally salutary influence upon research by requiring the experimenter to secure a wider and more practical knowledge of his problem. A research man who has to do some engineering is, on that account, much less likely to offer a solution which is based upon excessively simplified assumptions or to offend his more purely engineer-minded colleague by a know-it-all attitude."—Functions of a Laboratory Organization, by Robert R. Williams, Bell Telephone Laboratories, April 1932.

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"The ability of the land-grant college to make major contributions to government and society is predicated on a reputation for integrity in education and objectivity in research that must be kept inviolate. Any contribution by the college that would endanger this high regard would in itself be a violation of the principle of the conservation of its usefulness."—Iowa State College bulletin entitled "The Role of the Land-Grant College in Governmental Agricultural Programs," June 1938.

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"Until the advent of the so-called scientific method and the development of techniques for applying it, man's progress in developing physical things was not different from his progress in any other sector. It was slow because most of his assumptions about the *(Continued on page 522)*

# Water and the Land

By S. H. McCrory

WATER and the land together form our most necessary resource. On man's skill in their use his future will largely depend. On an occasion such as this it is perhaps proper to consider the broader aspects of their combined use for agriculture, the accomplishments to date, and immediate needs, and endeavor to forecast the future.

In general, the location of our land is fixed, although degradation is slowly changing its contour and boundaries. With our present knowledge and equipment only infinitesimal changes can be made in land masses, but changes such as those caused by erosion may vitally affect mankind.

Water used by man in his daily work has its origin in rain and snow. Its distribution over the land masses varies greatly. In regions of scanty rainfall, irrigation becomes necessary. Where there is an excess of precipitation, drainage is required if the lands are to be used for agriculture. Distribution of rainfall also has an important effect on the kinds of plants that grow in a given region. When man begins to cultivate the land, erosion caused by wind and water often becomes a serious problem. What, then, can man do to make the situation in regard to water and the land more favorable for his use? At present, when water is lacking for agriculture, we can, in some places, irrigate. Where there is too much we can drain, and we can so control the water that falls upon the land as to greatly reduce erosion or the accumulation of alkali. It sounds simple, but in reality it is a complex relationship, for as our civilization has developed, other uses than agriculture have grown up for land and water, and in planning for their use we must take into account not only the needs of agriculture, but of municipalities, power plants, wild life, recreation, and so forth.

When in July 1847 the Mormon pioneers arrived in Utah and camped on the banks of what is now City Creek, they plowed a furrow to lead the water out upon the parched lands. Then was born the modern land and water relationship. There are evidences in New Mexico, Arizona, and elsewhere in the great Southwest that primitive man had been irrigating these lands for hundreds of years. Here in California the Spanish padres had produced food for humans, and possibly for animals, long before the West had been invaded by the American explorer. Long before the settlement of Utah primitive man had been driven off the irrigated fields in the Southwest by alkali accumulations.

Since the memorable day 91 years ago, in Utah, when the big ditch or canal was measured by the number of plow furrows, water and land use in the West have gone forward with gigantic strides. The magnificent Boulder Dam and All-American Canal are only measures for today, and it is hard to conceive what may be undertaken tomorrow. The All-American Canal alone will carry enough water to irrigate an area four-fifths as large as all of the land now irrigated in Utah.

From a handful of people in 1847, there is now being supported by land and water use, most of the population of the arid states, and in much of this area agriculture is possible only through irrigation.

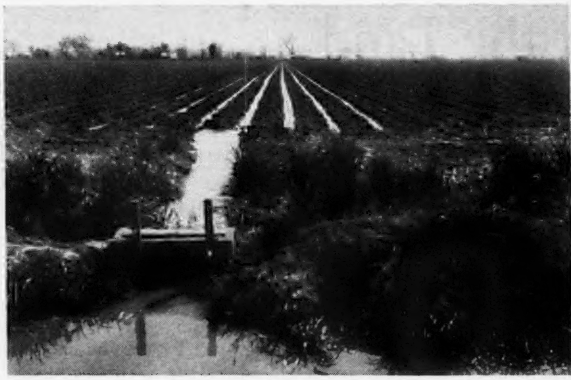
In the realm of investment, the figures are staggering for so young a country. They ran well over a billion dollars in 1930. According to the census of 1930, the value of irrigation works in Utah was nearly $40,000,000. The cost of the aqueduct leading water from the Colorado River to the metropolitan water district of southern California for domestic and irrigation purposes is more than five times this sum. This is capital investment in the conduit only. Land and water use costs are mounting and, as water becomes scarcer, these costs will go higher.

Of the land surface of the West, only about 2 per cent is in irrigated farms, and this 2 per cent of the land in many arid states makes use of most of the water falling upon all the land. Many of us who have seen irrigated lands and irrigation ditches consider the river or the reservoir from which the water is diverted as the source of the water. In reality, the water of summer and late season comes from the mountainous areas of the watersheds. The mountainous areas, which contribute the late July, August, and September irrigation water, are probably only about 10 or 12 per cent of the entire land area of these states. These catchment areas are the reservoirs from which come the life-giving streams. In many of the so-called "reserves" of the West lands, as well as forests, are managed and oper-

An address, as the 1938 recipient of the John Deere Gold Medal awarded by the American Society of Agricultural Engineers, delivered before the annual meeting of the Society, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: Chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Fellow A.S.A.E.

(LEFT) MAKING SNOW SURVEY MEASUREMENTS, THE BASIS OF STREAMFLOW AND IRRIGATION WATER PREDICTIONS. (RIGHT) CRATES OF CONCRETE AND CEMENT CYLINDERS UNDER TEST IN THE ALKALINE WATERS OF MEDICINE LAKE, S. D., TO STUDY RESISTANCE OF DIFFERENT CEMENTS AND MIXES TO ALKALI



(LEFT) IRRIGATION OF LETTUCE IN A FIELD WEST OF PHOENIX, ARIZONA. (RIGHT) WIDE-BOTTOM EURROWS ARE COMING INTO USE IN ORCHARD IRRIGATION IN THE WEST. BY THIS METHOD WATER SOAKS IN MORE LIKE RAIN

ated for water yield as the greatest asset. Thus the lands to be irrigated in San Bernardino County by the Boulder Dam aqueduct are several hundred miles from the water source. The production, improvement, and management of these watershed areas are land-use and water-use problems.

Because water is a scarce necessity in the arid region, practically all of the western states have recognized the use of water as a public benefit. Most of the western states declare in their constitutions that all waters within the state are the property of the state, to be held in trust for the use of its citizens. Various laws, in addition to the constitutional provision, indicate the public nature of water use, and the courts, both state and federal, have upheld such laws. In practically all states, and especially in the arid states, there are preferential water rights. First come those for human use, including the production of food, then those for industry, mining, recreation, and wild life. In most of the western states the constitution provides also that the measure and basis of a water right is beneficial use.

A water right is an important and valuable piece of property in arid sections. Water rights are acquired by applying to the state engineer or other designated state official, and upon completion of the works incident to the use of this water right, the applicant is granted a permit, or water right. This guarantees to him the enjoyment of the water so long as he makes beneficial use of it. If he fails to use the water for a stated period, varying with the different states, the right is declared abandoned and the water again becomes public property subject to appropriation. A change in use or a change in the point of diversion is possible only by applying for and receiving a permit from the state engineer.

In the early days the settlers had little in the way of funds or equipment. Ditches were built where the cost would be at a minimum, and usually with little regard to the quality of the land to be irrigated. Thus, the lower-lying ditches were first built. As additional settlers came, a ditch at a little higher elevation was constructed and thus we find in the older irrigated valleys many paralleling ditches. In the first part of this present century the federal Reclamation Act was passed, primarily for the purpose of bringing into cultivation the public domain of the West. Many of the earlier projects were located without sufficient regard to the quality of the land to be farmed, and with primary consideration for the engineering features. As time went on, land difficulties arose, both in private enterprises and in federal undertakings. Lands became waterlogged, alkaline, and in some cases entirely unproductive. As a remedial measure, drainage was undertaken and just recently careful attention has been paid to the land proposed to be brought under irrigation. Today we find drainage systems planned to be put in along with the irrigation systems, the idea being to prevent difficulties rather than to cure them.

In the early days of the work of the Bureau of Agricultural Engineering, then known as irrigation and drainage investigations, the water requirement of irrigated lands was determined by ascertaining the amount of water used by the better farmers. No attention was paid to the effect of the quantity of water so used, the fertility of the soil, or its physical behavior. Research studies were inaugurated to determine the water requirements of various plants grown upon various soils and under different climatic conditions. Today we study the plant requirements for water, the total amount of water needed in applying this amount to the plants, and finally the additional quantity of water that may be needed to control alkaline accumulations. These studies have also shown how to use the water more efficiently and thus irrigate a larger area with the same supply.

When water was more plentiful and the irrigated acreage was much less, there was little need for data that would give the dependable water supply of a stream. Systematic measurements of various western streams were undertaken, even in the last century, by both the federal and state governments. Today we have a record which, for the major streams, extends back over a number of years and gives us average, maximums, and minimums of stream flow, all referring to the past. The severe droughts of the past six or seven years have indicated the value of knowing in advance the water supply that may be anticipated during the season, for crop production. Spasmodic attempts were made during the past 35 years to predict the season's water supply by measurement of the snow cover in the mountains. California, Nevada, Oregon, and Utah had made considerable progress in this work, when, in 1934, the Bureau of Agricultural Engineering obtained funds for the purpose of correlating the present snow survey activities and extending the work into other areas. Since that time, with the assistance of the states and other agencies of the U. S. Department of Agriculture, we have made a good beginning in establishing snow survey courses in the watersheds that supply water to the irrigated areas of the West. Information on snow cover is exchanged with Canadian officials, especially on the Columbia River watershed. Where we have had the advantage of actual measurements of river flow as a check, the forecasts based on the snow surveys have been proved surprisingly close—98 and 99 per cent accurate in two cases of peak flow measurement.

In the first efforts to predict the water supply, only the

depth of snow was determined. Since the water content of snow varies from 2 to 6 in of water per foot depth of snow, it is readily understandable why early efforts were not very successful. The present method is to determine the water content of the snow cover, correlate this with the stream flow, and thus provide a basis from which to predict, not only the season's water supply, but its distribution throughout the season.

In the more populous areas of the West there is a continuous battle over water for municipal and agricultural uses. Thus we find subdivisions constantly encroaching on agricultural areas.

The problems of agriculture are complicated by increased valuation and its attendant tax rate, as well as having to compete with an increased water rate due to the proximity of domestic service, which can always afford a much higher price. Fortunately the two uses require about the same volume of water, so that the transition does not affect the areas served.

In many inland valleys which are entirely dependent on ground water as a source of supply, there is one serious aspect of this transition from agriculture to urban or city use. As buildings are erected, streets and sidewalks paved, less and less of the rainfall percolates into the soil, since more of it is led off into storm sewers and wasted into the ocean.

In what has been stated, an attempt has been made to give a rough picture of the continuous fight between conflicting uses for land and water, as well as the ever-mounting difficulties of obtaining a supply of water and the increasing cost.

In the improvement and protection of the watersheds; in the building of the dams, canals, and ditches; in the leveling of the land; in the plowing, planting, tillage, and harvesting of crops; and in the conveyance of these crops over long distances, are presented a variety of problems necessitating new and improved types of machinery and tools. There are diseases and pests requiring control that differ from those prevalent in the humid regions. New soil problems are encountered, as well as different types of farming and stock raising.

Drainage in some form is needed in both humid regions of the East and in the irrigated regions. Much of our best agricultural land east of the 100th meridian would be of little value without drainage. Some 84,000,000 acres have been included within organized drainage districts, and works

TRACTOR WITH LIGHT, PORTABLE BOOM AND SMALL SCRAPER, FOR MEDIUM JOBS, TOO BIG FOR HAND LABOR AND TOO SMALL FOR HEAVY EXCAVATION EQUIPMENT

costing more than $680,000,000 have been constructed. There remains much work to be done which would make existing drainage work better. In many districts improved outlets are needed. These frequently handle the runoff from large areas, and are expensive to construct. Perhaps the most pressing need in the field of drainage is improvement in the maintenance of drainage works. Neither the methods of maintenance nor the organization for providing the funds and doing the work have, in general, functioned well. The work of the CCC drainage camps has done much towards developing methods for this type of work. The job is admittedly difficult, and offers a fertile and promising field for study. From data compiled by the National Resources Board and from soil surveys, Olsen has shown that 77 per cent of the more than 16,000,000 acres of land in organized drainage districts in Iowa is classified as "excellent," or "good," indicating the successful functioning of the drainage improvements. Much has been done to improve the drainage of our agricultural land as shown by the 84,000,000 acres in drainage districts, just mentioned, and much tile has been laid, probably around 60,000 miles of it in the 35 drainage states. In the West great progress has been made in developing methods of draining irrigated land.

In the early days drainage works were put in by hand or with teams. As the Middle West was settled, the demand for larger ditches forced the development of the dipper dredge. By 1906 the demand was for larger ditches than could be economically built with floating equipment. The first dragline was built in 1906, and in 1907 a dragline excavator was used on a ditch in Iowa. This machine, crude as it was, gave such large output and low cost of excavation that within a few years the use of this type of excavator had become almost universal.

Underdrains, or tile, are of major importance on a large part of our farm lands. Much study has been given to the design and construction of tile drains; more is needed. The late D. L. Yarnell, who was a member of this Society, made important studies of excavating machinery for use in digging ditches for tile drains, and of the flow of water in such drains. Work of the CCC drainage camps under the direction of Lewis A. Jones (Mem. A.S.A.E.) on repair of tile drains, has shown a great many failures due to a variety of causes, and has emphasized the need for better construction and better design. To the old tilers of 30 to 50 years ago, tiling was an art, and fine workmanship a creed. They are gone. Perhaps such work, after all, is an essential of our agriculture, and the art should be reestablished. Where tile is needed, perhaps the agricultural colleges of the states concerned could hold schools to train such workers.

Efforts to keep irrigated lands productive in the face of alkali accumulation and too high a water table have led to wide use of underdrainage in the West. The practice was developed in this country largely by engineers of those offices of the Department of Agriculture that later became the Bureau of Agricultural Engineering. The original idea for this improvement in irrigation farming came, I think, from early English writers on the subject. Sir William Wilcox, the celebrated English engineer who built the Assouan dam in Egypt, when he was in this country in 1913, said the methods of draining irrigated lands here were the most important contribution to irrigation engineering he had observed.

The effect of erosion in lowering the value of or destroying our agricultural lands has long been appreciated by students of agriculture. Recently the public has also come to appreciate this. In 1913, studies of engineering problems involved in the control of erosion were begun by the U. S.

Department of Agriculture, and as the importance of the work was realized, it was expanded. With the creation of the Soil Conservation Service in 1935, a major increase in research on erosion control became possible. The work done to date has served to give a clearer conception of the importance of erosion, its tremendous effect on agriculture and the broad measures necessary for its control. The present large research program will, undoubtedly, soon make much clearer the causes of erosion, and show how it can be more efficiently and economically controlled.

What of the future of these problems of water and the land? As population in the West increases, the demand for water will increase. This will force the development of many supplies now considered too expensive and will bring about improvements in irrigation and other water practices with resultant savings that will make the present supply of water go farther.

In drainage work, we can confidently look forward to improvement in design of drainage systems. Greater emphasis will be placed upon methods of maintaining drains, both open and covered, and equipment particularly suited for this work will be developed. Already much work has been done toward making concrete tile more resistant to alkalies and acids in the soils. Our technique of erosion control will be further developed and improved, and new types of equipment will increase efficiency and lower costs.

If these things are to come true within a reasonable time, research, strongly supported, must push forward vigorously for new information on which better programs can be built. The problem is many sided and demands the work of many technically trained men in different scientific fields. Better organization is now making it possible for us to get the maximum out of our research efforts through cooperation of federal, state, and other agencies. The teamwork of water and the land is reflected in the teamwork used in solving the water and land problems.

# Research Viewpoints

*(Continued from page 518)*

future were faulty and most of his knowledge was essentially qualitative.

"As we all know, the scientific method which has proved to be so fruitful is nothing more than a mental concept which contemplates progress through the process of subjecting opinions and hypotheses to the test of controlled experimentation that can be repeated if required. The techniques which have been developed wherever the method is employed are merely procedures which we know will insure the necessary controls or measure results quantitatively.

"The real advances of science, both fundamental and applied, have been because the scientific method has given us not only better and more accurate knowledge about existing building blocks but likewise, and in ever-increasing measure, accurate knowledge about their component parts. As our knowledge has increased and the particles to which it applies have become smaller, the number and kind of new building blocks we can create has multiplied. So too have the entirely new useful structures which organized research has been enabled to construct. In the field both of fundamental and applied science the fruits of this process are legion.

"Like geographic discovery from the time of Columbus, the first completely new social application of a science result is likely to have the most disturbing effect. Subsequent improvements, while they may add much to the total flow, add merely to a stream that is already running.

"If organized research can be simulated to make maximum use of the increasing amount of fundamental knowledge, it will be equivalent to giving society more and finer building blocks. Society should thereby be enabled to construct more numerous buildings for itself and buildings better adapted to its infinite needs."—"The Challenge to Organized Research", by F. B. Jewett, in The American Institute Monthly.

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"There shines a glorious world in the dreams of creative discoverers and inventors in the field of engineering, because those creative dreamers know that civilization and the friendliness of man step forward as the scope of engineering widens. Creative science requires for its devotees keen powers of observation and fertility in inferences. Add to those qualities the further qualities of initiative, resourcefulness, courage, and (for engineers) a full sense of human relations, and the man may become either a great engineer or a great research scientist according to his tastes. Such men are prime agents for the further development of civilization. The process of engineering now has come to depend deeply on the expansion of knowledge in science in order that the engineers may possess the opportunity to make additional useful applications. Engineers therefore stand hand-in-hand with scientists for the sake of engineering and civilization."—"Engineering's Part in the Development of Civilization", by Dugald C. Jackson, in Mechanical Engineering for November 1938.

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By way of calling attention to the fact that the Committee on Research is facing an old problem we quote from an early issue of AGRICULTURAL ENGINEERING:

"Every phase of agricultural engineering should be based upon the results of careful research to give both satisfactory and permanent results. It is not within the province of this report to outline methods of procedure in individual research projects, but it seems advisable to call attention to some of the important points brought out in a recent editorial appearing in the Experiment Station Record (vol. 43, no. 4) on research projects in agriculture. It is pointed out that a project in agricultural inquiry is first of all a constructive scientific undertaking which aims to advance science and through it the art. Its purpose is (to find out and learn how), and thus to understand the purport of results obtained. It deals with things that are fundamental, aiming to disclose the underlying principles or conditions of relationship and seeking to develop basic facts and establish their universality. Originality in research implies going outside of what is known or practiced and injecting something new in purpose or procedure. The scientific method of advancing knowledge is the substitution of detailed and verifiable results for broad, unproved generalities derived from practice, or from inadequate experiment and speculation. A research project should have a definite aim and should be progressive in its conception and its conduct, proceeding in a systematic and orderly way from one essential point to another. Owing to its nature it is necessarily restricted in scope. It always looks toward completion and should be planned with this in view. It is recommended that wherever possible future work in agricultural engineering be planned with these points in view." —R. W. Trullinger in AGRICULTURAL ENGINEERING for January 1921, vol. 2, no. 1.

# Corn Planter Fertilizer Attachments

By M. G. Huber

(TOP, LEFT) FRONT VIEW OF FERTILIZER FURROW OPENERS ATTACHED TO SEED FURROW OPENER SHOE. (TOP, RIGHT) REAR VIEW OF FERTILIZER FURROW OPENER DISKS, SHOWING Y-SPOUT FERTILIZER DIVIDE AND THE COVERING WINGS. (BOTTOM) A ONE-ROW PLANTER DESIGNED FOR HEAVY APPLICATIONS, PLACING FERTILIZER IN BANDS BELOW THE SEED LEVEL

PROPER placement of fertilizer is considered important in order to eliminate any possible chance of seed or root injury, and to secure the largest possible returns. It has been definitely determined that a localization of fertilizer placed in bands as near as possible to the seed without injury produces the best results.

Double-strength fertilizer used 400 lb or more per acre is considered a heavy rate of application, although this is an arbitrary measure. The Maine Agricultural Experiment Station has conducted its investigations on the kinds of fertilizers and rates of application producing the best yields. In nearly all cases the placement was in continuous bands spaced 5 in apart, inside measurements, and on a level with or slightly below the seed. Fertilizer placement has not been a study, but heavy applications cannot be recommended without suggesting how it is to be applied.

Placement on or below the seed level will be in the vicinity of more moisture, thus resulting in the more rapid solution of the fertilizer, and making it more readily available for plant growth. It is also less likely to be disturbed by the covering wings or disks.

In order that desired placement can be obtained, it is necessary to have planting equipment that is equipped with the proper attachments to make double fertilizer furrows for band placement.

Two-row corn planters have side placement of fertilizer depositors or distributors. These depositors consist of a V-shaped deflector under the fertilizer spout which divides the fertilizer stream into two bands. They always place the fertilizer at a depth a little above the seed level. In planting sweet corn, which is generally not planted as deep as field corn, a careful operator is required to cover properly without disturbing the bands of fertilizer. Little field corn is grown in Maine.

The recommendations of the state extension service and experiment station suggest applications from about 500 to 800 lb of single-strength fertilizer per acre or proportional amounts of double-strength. The two-row planters most commonly used are designed for midwest conditions, where less fertilizer is applied per acre. Our experience has been that the average Maine farmer had too much seed and root injury.

A year ago only one planter was sold in Maine which would, in our opinion, fill the requirements for proper fertilizer placement using heavy rates of application without danger of seed or plant injury.

As a result of our efforts and suggestions, and the attempt of farmers and canneries to overcome some of these faults, the most commonly used one-row planter was redesigned with special castings made in local foundries and attached on this planter. This resulted in band placement at the desired depth and spacing. A year ago the manufacturer of this one-row planter redesigned it to comply with our recommendations.

The fertilizer furrowing projections on the plow wings were narrowed and extended forward in order to more readily open the soil and confine the fertilizer in a narrow groove. Small covering blades were attached to each side of the seed groove to serve as fertilizer covers from the inside. The action of these blades is to pull the dirt over the fertilizer immediately after it is dropped, before the seed has a chance to fall down or come in contact with it. Other minor improvements have also been made on the planting mechanism. This planter has been redesigned so that all the old planters can be changed over, making them equal in fertilizer placement to the new planters. The one-row planters practically filled the requirements for good placement. However, the two-row planters using the conventional split boot needed some attention. This job was undertaken primarily from an extension viewpoint.

In order to obtain the desirable depth for band placement we decided to use furrow- *(Continued on page 526)*

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# The Use of Vapor Spray in Plant Disease Control

By R. M. Merrill

INVESTIGATIONS in the use of water vapor as a means of applying insecticides and fungicides have been reported on previously before the Society[1], but a continued interest in this method of spraying seems to warrant a brief progress report covering the 1937 season. Field tests with the vapor equipment were carried on by the U. S. Bureau of Agricultural Engineering in cooperation with the Bureau of Entomology and Plant Quarantine and the Ohio Agricultural Experiment Station. The Bureau of Agricultural Engineering prepared the vapor equipment for field use and operated it in the field, and the cooperating entomologists and pathologists applied the spray and determined its effectiveness.

*Equipment.* To supply the water vapor a commercially available generator was purchased and altered to adapt it for agricultural spraying. This unit, as available on the market, consisted of a flash boiler or progressive water heater through the coils of which water was forced by a small triplex pump at a rate of about 1¼ gal per min, heated by a fuel oil burner and brought to a pressure of from 75 to 150 lb per sq in. Releasing the water and vapor at the orifice causes it to break into a finely atomized wet vapor. As commonly used commercially for cleaning brick and stone buildings, soluble cleaning compounds are put in the feed water.

To make the vapor equipment more suitable for agricultural spraying, several changes were made. Since most of the materials to be applied are insoluble in water it was thought advisable to inject them into the hot water or vapor beyond the heating coils to avoid any possible damage to the coils. A triplex pump was used to force 1⅝ gal of water per minute through the coils from the feed water supply tank. Another supply tank equipped with an agitator is used for carrying concentrated spray materials. Two cylinders of a second triplex pump force the concentrated materials at ⅝ gal per min into the vapor line beyond the boiler. The third cylinder of this pump furnishes fuel oil to the burner. This gives a total delivery of 2¼ gal per min at the nozzle. The oil burner uses approximately 4 gal of fuel oil per hour at a pressure of 100 lb which gives a vapor pressure of about 125 lb. The two pumps, the agitator in the solution tank, and the burner blower fan are operated by a 1-hp gasoline engine. For safety a pop valve is placed in the vapor line and a no-water-cut-off is provided to shut off the burner if the water supply to the coils fails for any reason.

To operate, the generator is fired until the desired vapor pressure is reached, after which the concentrated spray materials are introduced into the vapor line by opening a valve. These materials mix with the vapor at the point of introduction and in the hose as they pass to the nozzle or nozzles where the vapor when released carries the finely divided material to the plant or trees being sprayed. To carry the hot vapor safely from the generator, a ½-in steam hose with heavy couplings is used. To avoid the possibility of solid residues forming on cooling, when shutting off the outfit the spray material supply line is closed first so the water vapor will clean the hose line and nozzles.

*Field Tests.* Exploratory tests with commonly used insecticides, for the control of codling moth, pea aphis, grape root worm and grape berry moth have shown the vapor spray about as effective as the conventional hydraulic sprayer. However, the preliminary tests have indicated that some of the materials, for example derris, phenothiazene, and Bordeaux mixture, are apparently adversely affected by the heat of the vapor.

In disease control, the vapor sprayer has been used for apple scab, peach leaf curl, cherry leaf spot, and several vegetable crop diseases. In most cases the use of the vapor spray for applying fungicides has indicated greater possibilities than its use in applying insecticides. Many of the commonly used fungicides, liquid lime sulphur, dry lime sulphur, wettable sulphur, and dusting sulphur, have been applied effectively. Sulphur and combinations of sulphur and lime were distinctly more effective when applied with the vapor than when applied with the hydraulic sprayer. The heat of the vapor spray apparently changes the form of sulphur from the crystalline to the amorphous form which sticks well to foliage. Cheap grades of sulphur also seem to be as effective as the finer grades when applied in this manner. In spraying for disease control only about one-third as much water and fungicides was required for adequate coverage as compared with the hydraulic sprayer.

To offset to some extent at least the apparent advantages of the vapor method of spraying for disease control, several disadvantages are evident. It is quite apparent that a vapor generator must be of more complicated construction than a conventional hydraulic sprayer and, therefore, would probably give more operating difficulties. When a hose is required for applying the spray, the necessity for using heavy steam hose to carry the hot vapor is a distinct disadvantage. The vapor spray is not so effective on tall trees in wind as the heavier spray from the conventional spray guns. Heat has an adverse effect on some of the materials now used for spraying.

It is difficult to give comparative costs of spray applications with vapor sprayer and the conventional hydraulic sprayer, since the experimental unit used in tests is not of sufficient capacity to be comparable to the sprayers in general use. The tests made were primarily to determine the effectiveness of applications of the vapor spray as compared to the same applications by the conventional hydraulic sprayer. A fair comparison as to costs and speed of application cannot be made between the experimental vapor sprayer used and the hydraulic sprayers now in common use.

Experimental work with vapor spraying indicates that many materials can be effectively applied in this way, and it seems that the question of its adoption by growers is entirely dependent on whether it is possible to obtain a unit of sufficient capacity, economy of operation, and freedom of mechanical trouble to compete with the conventional hydraulic sprayer.

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Author: Agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

[1]"Water vapor for agricultural spraying," by R. M. Merrill, AGRICULTURAL ENGINEERING, May, 1937.

# Electric Pasteurization of Milk

By Ben D. Moses

EARLY in the nineteen twenties, a process for pasteurizing milk, by passing an electric current through it, was introduced into the United States from Europe. It met with some opposition, chiefly on two counts, namely, (1) the operation was so fast that it was classed as "flash pasteurization," and (2) there was some doubt as to the accuracy and dependability of the controls.

Until sufficient proof had been established that this type of pasteurization produced satisfactory reduction in bacteria and pathogenic organisms, without damage to the quality of milk, it was not approved by states having laws governing pasteurization. During the last ten years, however, this process has been under close observation by the health departments of various states, and it is a conservative estimate that at least 200,000,000 quarts of electrically pasteurized milk have been consumed without detrimental effects upon the health of those using it.

Pasteurization is fundamentally a heating process, and as I view the problem, the engineer's obligation is that of producing the physical conditions prescribed by the dairy and health authorities. He deals with the physical units, heat and time, that combine to produce the desired effect upon bacteria, pathogenic organisms and milk components. When these authorities tell him how much to heat milk and how long to keep it hot, his problem is then to design the heating and control equipment to produce these temperatures accurately and with dependability. His measuring stick becomes the clock and the thermometer, and the operator needs only to watch these two instruments to fulfill the requirements set up by federal or state regulations.

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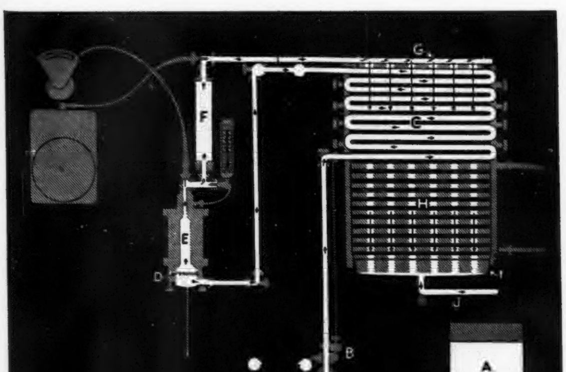


DIAGRAM OF MILK FLOW THROUGH ELECTRO PASTEURIZER. MILK FROM A IS FORCED BY A CONSTANT FLOW PUMP, B, THROUGH A "HEAT REGENERATOR", C, WHERE IT IS WARMED TO APPROXIMATELY 125F BY THE HOT MILK COMING FROM THE "CHAMBER" F WHERE IT IS HEATED TO APPROXIMATELY 160F BY THE ELECTRIC CURRENT PASSING BETWEEN CARBON ELECTRODES FORMING TWO SIDES OF THE CHAMBER, UPWARD THROUGH ANOTHER CHAMBER WHERE IT IS HELD AT 160F FOR 15 SEC. IT THEN FLOWS THROUGH OVER THE HEAT REGENERATOR AND DOWNWARD OVER A COOLER TO BE BROUGHT TO THE FINAL TEMPERATURE, APPROXIMATELY 40F

Many states have written into their regulations for producing milk to be used for human consumption about as follows, which I quote from California regulations:

"The process of pasteurization . . . . . shall consist of uniformly heating such milk, skim milk, or cream, as the case may be, to a temperature of not less than 140 degrees Fahrenheit and holding the same at a temperature between 140 and 145 degrees Fahrenheit for a period of not less than 30 minutes . . . . . ."

Such a requirement eliminates any process that holds the milk for shorter periods than 30 min and prohibits temperatures greater than 145 F. However, it has been proven to the satisfaction of six states, namely, New York, Pennsylvania, Connecticut, Illinois, Michigan, and Maryland, that effective pasteurization can be obtained by heating milk to 160 F and holding it there for 15 sec without any detrimental effect upon the quality of the milk. In fact, milk so pasteurized has stood the test of both the controlling authorities and the people who drink the milk. As a result, these states have amended their dairy laws by making some such provision as the following; I quote from Bulletin No. 12, Dairy Laws of the State of Connecticut, (Revised August 1, 1935): "The process of heating every particle of milk or milk products to 160 degrees Fahrenheit, holding the same at that temperature, or above, for not less than 15 seconds in apparatus designed and operated in accordance with the specifications approved by the dairy and food commissioner and then cooling it immediately to a temperature of 50 degrees Fahrenheit, . . . . . The term 'pasteurized', or any similar term, when used in connection with milk or milk products, shall mean such milk or product which has been subjected to the process of pasteurization, as herein defined." (1, 2.)[1]

That the process meets with the approval of the milk producer and his customers is attested for by the fact that there are now between 40 and 50 electric pasteurizers in daily use pasteurizing milk or cream for probably 50,000 consumers. So far as I have been able to learn, no one who has ever used this process has deserted it. Evidently, then, it is satisfactory to the three parties most concerned, the customer who wants good pure milk, the producer who wants to conduct his business on a profitable basis, and the authorities who stand guard against the transmission of disease.

Essentially, electrical pasteurizing equipment consists of a vertical, rectangular tube, two sides of which are made of carbon, and two sides of glass. The milk to be pasteurized is pumped upward through this heating chamber and becomes the conductor of an electric current between the two carbon plates. This current produces rapid heating. Because of the uniform distribution of the current and because the electrodes are kept at a constant temperature by a water jacket, the milk that passes through the chamber is uniformly heated. The rate of flow and the voltage impressed are such that the temperature of the milk is raised

[1]Figures in parenthesis indicate references listed at the end of this paper.

to 160 F by the time it reaches the top of the chamber. The milk then flows through another chamber, so dimensioned that a holding time of 15 sec is provided. The heat flow is from the milk outward, and as the milk flow is upward, the thermal control element can be quite accurately placed at the hottest point.

There are three ways that the temperature can be controlled: The flow can be kept constant and the voltage on the plates varied, the voltage kept constant and the milk flow varied, or a combination of the two. The latest control works on the voltage in such a way that, when the milk is too cold, the voltage is increased and when the milk is too hot, the voltage is lowered.

The thermal element, which operates the voltage regulator, consists of an alcohol-filled bulb that is placed in the milk stream at the top of the heating chamber. A long small bore tube connects the element with a Sylphon bellows, which in turn moves the magnetic armature of an impedence bridge. Any change in the armature gap will result in a corresponding change in the voltage of the bridge secondary.

Through a series of saturable core reactors, the voltage across the terminal plates is accurately controlled and the entire operation is automatic after it is once started. A complete elimination of moving parts in the amplifiers, the constant flow of milk through a sealed pump, and the resulting close regulation, insure uniform heating and definite holding time.

The operation of this hook-up is so perfect that a thermometer placed in the outgoing milk shows an overall variation of less than 2 deg F, and can be adjusted much finer if necessary. Every machine must have the pump adjusted so that 15 sec is required for the milk to flow through the heating compartment and the discharge pipe, before the inspector will give his approval. The pump control is then sealed, insuring the proper holding time. This combination of temperature control and flow regulation heats the milk to 160 F (or whatever the law demands) and holds it there for 15 sec. Should there be any need for changing either the temperature or the time, the adjustments are simple to make.

It is not possible to obtain regulation until the machine has been operating long enough to obtain a balance between the electric current and the rate of milk flow. This "warming up" of the machine is accomplished each pasteurizing period by setting the voltage regulator in the maximum position, and starting up on salt water, the conductivity of which is about the same as that of the milk. When the system becomes thoroughly warmed, the controls are set to hold the temperature at the desired value and milk is admitted to the pump. This milk pushes the water out of the system until it is filled with milk and the temperature stays as set. The first few gallons are caught in separate cans and put with the milk to be separated.

After the pasteurization has been completed, the entire apparatus is cleaned, sterilized, and reassembled.

Because this method is continuous, it is possible to pass the milk from the pasteurizer through a regenerative cooler in such a manner that the outgoing hot milk warms the incoming cold milk. This effects a considerable saving in the energy used for heating and reduces the load on the cooling water and the refrigerating machine.

This continuity of flow also permits the pasteurization of different batches in a continuous stream without any delay of emptying and refilling between lots. During the pasteurizing period, it is a simple matter to pasteurize milk brought in by different customers and keep the lots separate. It lends itself very nicely to custom work.

Every dairyman using this process, in the state of New York at least, is required to keep a file of the temperature charts. The inspector makes occasional calls, checking the accuracy of the thermometer, the temperature variation of the records, and the continuity of the charts.

So far as the electric load is concerned, it is quite satisfactory. It has a high power factor, is about 15 kw, and is continuous. In the aggregate this load tends to be a little peaky in character, because most dairies pasteurize at about the same time, between eight and twelve in the morning.

In discussing this process with some of the owners, they bring out the following points:

1 The bacteria count is low.
2 The cost of operation is not greatly different from other methods, at least it is no higher.
3 The control is entirely automatic.
4 Comparatively small floor space is required.
5 The process is continuous and fast, and permits the handling of several batches of milk in a simple manner.
6 There is a definite check on the time and temperature used.
7 There is no local heating.
8 High quality milk is produced; the consumers like it.
9 The cream line is good.

REFERENCES

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2 Dairy Laws of the State of Connecticut, etc. Bulletin No. 12. Dairy and Food Commission, State Office Building, Hartford, Connecticut.
3 Report by Dr. Sam C. Prescott, Journal of American Health Association, March 1927.
4 The Electrical Conductivity Method of Processing Milk, by J. C. Fetterman, AGRICULTURAL ENGINEERING, April 1928.
5 Paper by Ralph E. Irwin, Chief of Division of Milk Control, Pennsylvania State Board of Health, Harrisburg, Pennsylvania.
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## Corn Planter Fertilizer Attachments

*(Continued from page 523)*

ing disks similar to those used on a potato planter, largely because such disks were readily available from the manufacturer, though designed and sold specifically for another purpose. The two different makes of planters most commonly sold had these disks available that could be easily attached. However, the fertilizer hopper feed on the old-style mechanism consisted of a single feed from each hopper, which necessitated a Y-divide for distribution in a band on each side of the seed when using the disks. We felt that a double fertilizer feed on each hopper would be a more desirable feature, because of the difficulty of proper division on hillsides. Rigid covering wings were used to cover the fertilizer and corn. No fertilizer was brought to the surface by the covering wings, which was a common and sometimes a continuous occurrence in the old-style mechanism, resulting in either killing or retarding germination.

These attachments, except those as standard equipment, may not be perfect in all respects. They do, however, a very satisfactory job.

In these experiments, we cooperated with implement dealers and district salesmen in promoting the use of these newer attachments. Some dealers are planning to sell planters without the split boot, but equipped with the new attachments.

# Problems of Flow of Water of Special Concern to Agricultural Engineers

By Fred C. Scobey

PROBLEMS of flow of water come to the agricultural engineer usually in terms of carrying capacity in two phases. He must determine *how much* water is to be conveyed for a particular purpose and in *what type* and *material of conduit.* The irrigation and drainage engineers have most of the problems of conveyance, while the agricultural engineer with a small organization may find himself called upon for the solution of most any problem in engineering, including pumping plants, water-supply systems, sprinkling layouts, and so on. These problems may be far removed from his specialty and from the work for which he was nominally engaged. If he is an "engineer", then many small organizations feel that he may be called upon for solution of any engineering problem that may arise. Fortunately, the groundwork in modern colleges is such that he will often surprise himself in the aptitude with which he will tackle and whip problems he would not have dared face unless they had been thrust upon him.

In drainage work the engineer knows approximately the quantities of excess water that can come to the area he is considering, and a combination of economic and agricultural conditions dictates the rapidity with which this water must be removed.

In Mississippi many years ago my personal problem in drainage lay in developing flow in drainage canals where there was little or no slope to the land in any direction. There I learned that a long level canal would still carry water if the water could be piled up at one end. Probably this problem is much more common in drainage than in irrigation work. The one locality in the United States where similar conditions prevail on irrigation canals lies in the same general country—Louisiana and eastern Texas. These canals, largely used for rice irrigation, are really long reservoirs into which water is pumped at one end and a grade established by raising the water at that end. If pumping stops, the surface seeks its own level and flow is suspended until pumping is resumed.

Irrigation engineering requires a blend of civil and purely agricultural engineering. The civil engineering phase predominates during original construction and the agricultural afterwards, during operation. However, before construction the planning engineer must know or assume the duty of water in terms of canal capacity. In other words, the problem is for what quantities of flow must canals and laterals be designed? This subject is but little discussed in engineering literature.

The Imperial Valley system of southern California was laid out on a canal duty of one second-foot of water per 100 acres of land. On such a basis the new All-American Canal would serve 1,000,000 acres. After a few years of operation it became evident that one second-foot of capacity was sufficient for 150 acres. In the citrus groves of Arizona and California this duty is increased until about 400 acres per second-foot has been attained.

At the other end of the scale, many streams in Colorado were adjudicated on the basis of one second-foot for each 40 acres of land. All of the irrigators in Wyoming are served on the assumption of one second-foot for each 70 acres at the canal head, which becomes about 80 acres of land actually irrigated, after losses in main canals and laterals are deducted. These basic canal duties are easily handled for mains and even fair-sized laterals, but what of the small areas that rate but a fraction of a cubic foot per second?

Here the knowledge of the engineer must cover the size of irrigation "heads" in his particular system. In open field laterals and furrows it is seldom that less than one-half second-foot can be employed economically. On the other hand, certain areas in San Joaquin Valley are irrigated with heads of 15 to 20 second-feet. Obviously, canal duty cannot be extended on a proportionate basis to small areas if local usage calls for greater heads. Again returning to Wyoming, we find that claims to water for irrigation are all handled on the proportionate basis, no matter how small may be the area to be covered. For instance, we find a certificate issued to Almira Leavitt for 0.21 second-foot to irrigate 15 acres of land. Such an award must be tempered with irrigation sense, as a flow of 0.21 second-foot would be quickly lost in a short distance of conveyance, and there would be difficulty in getting the 15 acres irrigated *once* before a second irrigation would be required at the place of beginning. Also, the cost of irrigation attendance would be the same for this small flow as for several times the awarded amount. Obviously, the solution lies in allowing the appropriator a much larger quantity of water than the nominal "right" for a proportionately shorter period of time. This is accomplished by rotation.

### RESPONSIBILITIES OF THE OPERATING ENGINEER

After the irrigation system has been constructed, the operating engineer is called upon for all his personal qualifications. He must still be a civil engineer to the extent of handling extensions, repairs, and replacements to the system. He must be an agricultural engineer with a working knowledge of many things—particularly of soil moisture, quality of water, wilting characteristics of crops, and the influence on crops of time and other conditions of irrigating. A prime requisite is ability to get along with the farmers without sacrificing firmness on his own part. He must have sufficient knowledge of water law to avoid getting his organization and himself involved in expensive adverse litigation. This same knowledge will also protect his company and himself against unlawful encroachments of others. It is axiomatic in the West that those who may be perfectly upright in all personal dealings with a fellow

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man will stoop to the most underhanded procedures to secure water to which they are not entitled under the law.

No large systems, and few small ones, are equipped to supply irrigation heads to all of their farmers at the same time. This requires schedules of delivery which may or may not be elastic. In some localities a complete schedule for the season is worked out in advance. In many systems water is supplied on demand, with a margin of time for necessary adjustments. In times of shortage, water is best delivered in a few main laterals for a time and then changed to another set of laterals. This may be done in the face of the fact that, under the law, each farmer may be entitled to his pro-rata share of the water. If such procedure were claimed and adhered to, then more crops would be lost because of inadequate service. All this points out the mere elements of the human, legal, agricultural, and civil phases of engineering that are encountered in the West in the conveyance of water.

After determinations of the amount of water that any particular conduit must carry, the engineer must take stock of the various possibilities open to him. These subdivide into open and closed conduits. Usually the topography and the type of service dictate which of the two are to be used.

### CARRYING CAPACITY

This is the phase of water flow that most concerns the agricultural engineer. Details of this subject can be found in a series of bulletins issued by the U. S. Bureau of Agricultural Engineering and listed at the end of this paper. Altogether this series contains some 600 pages of detailed discussion on capacity alone. The reader is referred to these papers for suggestions regarding capacity problems.

*Open Channels.* The agricultural engineer of the Middle West is very familiar with the open drainage ditch, supplemented with tile feeders, in the fields. Obviously, lining such a ditch would, in a measure, defeat its object. In the West many of the old irrigation canals, originally excavated in earth and operated as an earthen canal for many years, were eventually lined with concrete. Now it is almost the rule to line a canal as soon as economically feasible in localities where water has more than a nominal value, except where the system is equipped to recover by pumps any surplus ground water. These linings are of poured or shot concrete and sometimes of cement mortar. They cost from 6 to 12 cents per square foot for thin linings in warm climates, and from $5 to $15 or $20 per cubic yard when laid in thicknesses of several inches. Concrete lining has three purposes: (1) To reduce seepage losses, (2) to increase capacity for a given size, and (3) to allow velocities down steep slopes that would not be permissible in earthen channels.

The reduction of seepage is most effective for a good grade of concrete. Poor, lean concrete may leak almost as much as the earthen canal without lining.

Increase in capacity for a given size is brought about by increase in velocity due to the smoother interior surface and to the decrease in aquatic growths. What might be termed "super-capacity" can be developed by exceedingly smooth concrete, but this can hardly be maintained unless the concrete is of hardness commensurate with any abrasive matter in the water.

In the following paragraphs will be given short descriptions of the more common types of open and closed conduits that are available to the engineer. Their relative capacities are about as listed.

If a good grade of concrete lining be rated at 100, then other materials of construction will have relative capacities about as follows:

| Type of channel | Approximate range of capacity-rating | Approximate rating as result of usual design assumptions |
|---|---|---|
| 1 Troweled concrete, poured or shot, clean | 90-110 | 100 |
| 2 Shot concrete, without smoothing treatment | 75- 85 | 80 |
| 3 Shot concrete, well broomed | 85- 95 | 92 |
| 4 Poured or shot concrete, muddy waters | 85- 95 | 92 |
| 5 Best of concrete canals, clean | 100-131 | 108 |
| 6 Earthen canals, good condition | 52- 65 | 58 |
| 7 Cobble-bottom canals | 43- 52 | 48 |
| 8 Nos. 5 or 6 with dominating aquatic growths | 19- 35 | 30 |
| 9 Rock-cut canals | 26- 52 | 35 |

*Pipe Lines (three-inch diameter or larger).* If ten-year-old full-riveted steel pipe be rated at 100, then other kinds of pipe will have relative capacities about as follows:

| Type of pipe | Approximate range of capacity-rating | Approximate rating as result of usual design assumptions |
|---|---|---|
| 1 Riveted steel pipe—button rivet heads; 10 yr old | 69-110 | 100 |
| 2 Sheet metal, flat-head rivets masked in coating | 100-116 | 110 |
| 3 Heavy steel pipe, girth-riveted only | 100-120 | 106 |
| 4 Heavy steel pipe, all seams riveted | 70- 90 | 80 |
| 5 Continuous interior pipe (no rivets or rivets countersunk) | 100-130 | 118 |
| 6 Wood-stave pipe | 100-122 | 109 |
| 7 "Cement" pipe, hand tamped. Short units. Interior brushed with cement mortar | 50- 70 | 60 |
| 8 Concrete pipe, machine-made, for irrigation use | 92-113 | 104 |
| 9 Concrete pipe, best grade, for municipal use | 125-130 | 122 |

Metal pipes are more subject to the chemical action of active (eastern) and relatively inactive (western) waters. Likewise, their capacities are more dependent on the type and durability of dipped coats. This is evidenced by mechanical roughness of flaking coats and by tuberculation of metal surfaces where coatings have been abraded or have flaked off.

The table above is for pipes 3 in or more in diameter. The practice of the agricultural engineer has increased during the past few years in the matter of sprinkling systems for irrigation. The author has had but little experience with the small pipes used in this work. However, the tendency is to use too small a pipe. Fortunately, in all "line pipe" below the nominal 2-in size, the actual area is more than the nominal area, ranging from 54 per cent for the ½-in pipe to 15 per cent for the 1½-in pipe. If the engineer has any doubt as to the pressure heads available to satisfy given outputs, it is well to couple up the line on the ground surface and attach all the accessories, such as valves, sprinkler heads, and so on, and try out the line before any permanent burying of the line. If found that the capacity is inadequate, then all or part of the line can easily be replaced with a larger size. Remember that available pressure head at a source is rapidly converted to velocity head and excessive friction losses in the smaller sizes. The velocity head may or may not be partially recovered at the outlets in their "spouting" velocities. Such systems require not only the delivery of certain quantities of water to the outlets, but there must be a reserve pressure right at the sprinkler heads to make them function properly.

NOTES ON WATER CONDUITS

*Earth Canals (most common type).* Best capacities are developed in smooth sections without debris in canal and without aquatic growth; poorest capacities where channel is choked with heavy mosses. Permissible velocities range from about 1.5 ft per sec for fine sand and clear water up to 5 ft per sec for canals in slick alluvial silt conveying muddy waters that contribute a protecting coat of colloidal mud. Usual velocities are about 2.5 to 3 ft per sec. Earth canals are cheapest in first cost. Canals on filled ground may show excessive seepage losses and result in lawsuits for loss of crops and seeping of adjoining lands. The remedy is good concrete lining.

*Concrete Linings.* These are the usual goal of agricultural engineers. They save water and space on ground, as small sections, compared with earth canals, are feasible and desirable. They permit any velocity likely to be encountered. Continuous flow velocities range up to 25 or 30 ft per sec, and occasional flows of 100 ft per sec are permissible in first-class concrete. Highest capacity is obtained in carefully troweled surface in mixtures as dry as can be worked. These specifications result in strong, hard concrete that tends to maintain high capacity. Shot concrete is much used in parts of the irrigated West. As shot, the resulting surface is some 20 per cent short in capacity but is dense and water-tight. It may be treated by light troweling (not "pulling" the surface) to improve capacity to par rating without serious detriment to quality of concrete. All "rebound" should be removed from the canal. It has poor cementing properties and results in soft, leaking concrete if allowed to remain in section. "Shot" canals usually have richest concrete near top of sides and poorest at bottom. The opposite trend is most desirable. Using a richer mix toward the bottom is suggested.

*Flumes.* In the conveyance of water, many situations arise where there is a depression to be flumed or a hillside is so steep that it will be difficult to maintain an ordinary or even a lined canal. On such hills a flat "bench" is excavated in the hillside on the desired gradient, and a flume constructed along this so-called "grade". Until the beginning of this century there was little choice of materials. Practically all flumes were rectangular wooden-box structures, resting on a framed trestle or on a bench as mentioned above. While this primitive type of structure is still used, it has been largely superseded by more permanent construction where the extra money is available. Now flumes of sheet metal, made under various trade names, are suspended on steel rods between girders. The substructure is now made of steel bridge members as well as of timber. Wood staves, like, say, the bottom three-fifths of a stave pipe laid on its side, are supported on cradles carried by the trestle or on mud sills laid on a bench cut. Concrete is extensively used for bench flumes and is also placed on concrete trestles and arch bridges. The flume is essentially a high-velocity structure, generally placed in short lengths between open canal sections of lower velocities. The hydraulic solutions to the problems arising are often imperfectly understood even by engineers of extensive experience. For guides in such solutions, the reader is referred to the examples given in Technical Bulletin 150, listed at the end of this paper.

*Concrete Pipe.* Made in several grades of concrete, with varying capacity. Short-section, hand-tamped pipe with cement mortar interior wash comprises several thousand miles of lines in the warmer zones of the southwestern states, particularly in California. Most of this was laid prior to 1920. Its capacity is only about 75 per cent of the modern machine-made pipe now extensively used to the almost complete exclusion of the old handmade pipe. The machine-made pipe is in slightly longer units, with the interior usually left as it comes from the machine. The wiping of the interior surface in this manufacture gives a better capacity surface, and while carrying some 33 per cent more than the handmade pipe, its capacity is still some 14 per cent below that of the best of centrifugally-spun pipe or the lock-joint pipe. The Bureau of Reclamation has used the lock-joint pipe in sizes up to about 48 in in diameter for many years. However, they have used forms only about 4 ft long, while the modern pipe of this type for municipal use is made in joints 12 ft long and comes 20 ft long for submerged installations.

Concrete pipe is not subject to tuberculation, but inferior concrete may break down in badly alkalied soils. However, rich concrete appears to have been successful in mildly concentrated alkali soils of the Umatilla Project, Oregon.

A modification of the concrete pipe is made by wrapping a mixture of neat cement and asbestos fibre on a polished steel mandrel. This pipe, developed under the name "Eternit" in Italy is now made under the trade name of "Transite" in the United States. Several types of joint are used for field assembly. This pipe has a smooth interior, does not carry electric currents, can be sawed like wood, is very light, and can be tapped for corporation cocks just like a cast-iron pipe. Some of the lines in Italy are now more than 25 years old. Developed for municipal use, this pipe is probably too costly for agricultural use unless special concessions are made. It rates in capacity with the best of pipes of any material.

*Wood Stave Pipe.* The Douglas fir and the redwood of the Pacific Coast states have been extensively used in the manufacture of stave pipe. Two general types are made—the machine-banded, up to about 30 in as a maximum diameter, and the continuous-stave, from 1 ft up to 19 ft in diameter, with designs under way for one said to be 30 ft in diameter. The machine-banded pipe is made in lengths in a factory with bell ends or equipped for assembly with collars of similar construction. Formerly, the fir pipe was seldom treated with a preservative, and its life was very limited in certain soils. Present practice is to treat with creosote nearly all fir lines, and a life of 35 years or longer is predicted. Redwood is inherently long-lived, and, so far as the author is aware, has not been treated to extend this life. The author knows of redwood pipes under very slight pressures that were operated some 30 yr. In irrigation practice the point most adverse to the use of stave pipe lies in the seasonal withdrawal of water. Intermittent wetting and drying are not good for such lines. They dry out and then leak badly while swelling to hold water again. While a new dry stave shows a very smooth machined surface, yet in practice the interior changes more or less under saturation conditions and its capacity is slightly less than that of the best of concrete pipes.

*Metal Pipes.* Great changes have been made in iron and steel lines the past few years. Where the term "riveted pipe" was standard for metal pipes a quarter century ago, now we find but little riveted pipe made. The welding process has been so developed that even the flat-head riveted irrigation pipe is largely superseded by welded lines. This welding may be along only the longitudinal seam or on both longitudinal and girth seams. New processes now turn out spirally-welded pipe *(Continued on page 530)*

# Plant Disease Control Problems

By C. Emlen Scott

MORE than 400,000 acres of deciduous fruit and nut trees in California are sprayed at least once, much of it twice, and some of this acreage receives six or more applications each season. Some of these trees are also dusted, but most of the regular applications of insecticides and fungicides are made as dilute liquids or suspensions. Studies have shown that it costs from $4 to $6 per acre for each application and there is an initial investment of $10 to $30 per acre for spray equipment.

Four factors influence the efficiency which may be secured in a pest control program. These are the chemical, the time of application, coverage, and the amount of hold-over or previous abundance of the pest. The first three factors are very closely linked with the machine and will be discussed here largely from the viewpoint of what is needed to raise the percentage of control.

The question of sprays versus dusts has long been a controversial subject, but the fact remains that we largely depend on liquids in our regular programs on these deciduous trees. Dusts are used with entire satsifaction on many crops for certain pests, but there have been no developments to indicate that dust will soon replace the commonly used sprays. Many programs include a combination of materials for two or more pests. The discovery of a dust for one of these would be of little value until the others could also be controlled by dusts. It appears that spraying will be the standard means of controlling many of the worst pests for years to come.

Present practice in spraying involves some means of applying 300 or more gallons per acre. To do this we must either haul or pipe the liquid through the orchard. Some of the obvious difficulties inherent with these two methods are avoided by machines designed to apply chemicals in concentrated form in the ratio of about 10 to 1 compared to ordinary spraying. Not all of our standard fungicides and insecticides lend themselves to this method. It appears that extensive use of such equipment must await development of materials designed for the purpose. Some spray materials, especially some insecticides, are more effective at high temperatures and machines are now being used experimentally that heat the liquid as it is applied. This may prove very effective for special cases, but the method will not be of general use in orchard pest control.

Most of our standard spray programs are mainly protective in action. Sprays are applied to the leaves and fruit to protect them against the pest. In many cases the sprays must be repeated to keep pace with new growth and loss of materials. In several instances we are able to destroy the overwintering stage of the pest. Such programs are highly satisfactory because the job can be done over a period of several months and applications need not be repeated. Several diseases which are now controlled only by protective methods are being attacked experimentally by means of eradicants. With the aid of chemicals not previously used on trees, I look for real progress in controlling several diseases within the next few years. These developments will not give rise to mechanical difficulties but rather will greatly simplify some of the growers' operations. I believe that real progress with a number of the pests which are now controlled with difficulty can only be made by methods which strike at the dormant stage. This is largely a question of chemicals.

The second factor in orchard spraying is correct timing of the application. Mud, wind, and rain frequently cause delays resulting in serious crop losses. There are probably more losses from this difficulty than from any other factor. The first of these, mud, can largely be conquered with pipe lines. Permanent installations are not economically possible in stone fruit orchards. More encouragement should be given to portable pipe lines by the selection or development of equipment suited to the purpose. The handicap of wind in a number of cases is avoided by night spraying. Proper lighting for night sprays presents no great difficulty.

The application of chemicals as dusts or in concentrated mixtures involves light-weight equipment which avoids these difficulties of timing to some extent. However, these methods which are of value against certain pests cannot immediately replace the spray machine.

Adequate coverage of the tree involves two factors, one chemical and one mechanical. Unfortunately, entomologists and plant pathologists have not developed definite standards. Spray pattern and size of particle are two subjects which deserve more study. At the moment the more pressing question is that of complete coverage of the entire tree. This is particularly true where the operator works entirely from the ground on trees in foliage.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 30, 1938.

Author: Extension specialist in plant pathology, University of California.

# Problems of Flow of Water

*(Continued from page 529)*

in almost any length found feasible. After vertical dipping, these modern pipes present a smooth surface to the flow of water. Various agencies have turned strong endeavor to the development of coatings that would be smooth and long-lived. How well they have succeeded, time only will tell. For special uses metal pipes to withstand great pressures are made in continuous form with only field joints.

BULLETINS

The U. S. Department of Agriculture has published the following bulletins on the general subject covered in this paper. Most of them can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at prices given:

Tech. Bul. 129 "Flow of Water in Drainage Channels"—Author, C. E. Ramser. 40c.

Tech. Bul. "Flow of Water in Irrigation and Similar Canals"—Author, Fred C. Scobey. 25c. (In publication).

Dept. Bul. 376 "Flow of Water in Wood Stave Pipe"—Author, Fred C. Scobey. 25c.

Dept. Bul. 852 "Flow of Water in Concrete Pipe"—Author, Fred C. Scobey. 25c.

Tech. Bul. 150 "Flow of Water in Riveted Steel and Analogous Pipes"—Author, Fred C. Scobey. 30c.

Tech. Bul. 393 "Flow of Water in Flumes"—Author, Fred C. Scobey. 15c.

# Erosion Control on Steep Irrigated Slopes

By Harry E. Reddick and John G. Bamesberger

A TRUE concept of the proper utilization of any land, we believe, must embody the requirement of preservation of the land and the avoidance of practices which destroy fertile soil faster than it can be built up. This statement is rather generally accepted by all of us, and it is recognized that it applies equally to all localities and to all types and conditions of farming. However, there is a false idea, a false sense of security, fixed in the minds of many of our people that irrigated farm lands are inherently protected from such depletion and need not be considered as erosion problem areas.

That such is not the case is quickly shown by the first superficial investigation. From California, Washington, and Utah, among other states, come reports of large acreages being washed away in a few years, not by rain water, but almost entirely by irrigation water. Most of us have observed many instances of improper application of irrigation water which was causing severe erosion, and those who have not noticed need only be observant while here in California to see many examples.

The problem of erosion resulting from improper irrigation is with us, and it might aptly be termed one of our most lusty problem children. That the problem is rapidly spreading is evidenced by new areas being irrigated in the prairie states, and that it will continue to spread is indicated by the interest shown in supplemental irrigation all over the United States. The fact that erosion from improper irrigation is a problem child rather than a problem of long standing is indeed fortunate, because its youth should simplify the task of applying corrective education.

Erosion as a result of irrigation seldom occurs on the broad and fertile valley floors, because nature left the land on such gentle slopes that it is generally ideal for irrigation. However, surrounding these valley floors are slightly steeper lands which, in turn, are usually bordered by gently sloping foothills; and, although it is not so well known, a great deal of the richest soil in the West is located on hillsides, and a large portion of this fertile hillside land is irrigated. It is of these lands with the slightly steeper gradients and the foothill areas with tilled slopes, frequently of 50 per cent or more, that this discussion is concerned.

The hydraulic laws governing the flow of irrigation water in no way vary from those which govern the flow of rain water. Consequently, the same broad principle is applicable in both cases. We must either slow the water to a noneroding velocity or provide the soil with a sufficiently effective protective cover. In practical application, this means that contour irrigation, sprinkling, or basin irrigation should be practiced on all lands where a good permanent cover crop is not established.

Before proceeding further, however, it might be well to define some of the terms used in preparing this paper. A contour is a line joining points of equal elevation, and when the term "grade contour" or "grade line" is used, it means a line joining points that fall on a true grade. "Contour irrigation" refers to irrigation on a "grade contour", or "grade line". This differs from a true contour but, in general, will have the same shape or curves.

It is not unusual to encounter fear or reticence on the part of the average farmer when he considers laying out his farm on a contour plan because of the curvature of rows. Contour irrigation and cultivation in either open fields or orchards need not be as difficult or as costly as many think. When once laid out and after grade lines are run in, care should be taken to smooth up the curves because of the fact that Nature herself does not provide abrupt changes in land contours and because it is neither necessary nor desirable to include such changes in tree or crop rows. These kinks or dog legs are, of course, more or less inevitable when contour systems are first installed, but they can invariably be smoothed out without seriously interfering with the adopted grade. Experience has shown that with the first irrigation parallel to the grade line, the minor irregularities are automatically taken care of and adjusted by the water itself. This is a case where erosion is actually assisting the farmer in his irrigation practices.

Contouring alone cannot and has not been suggested as a method sufficiently successful within itself to control

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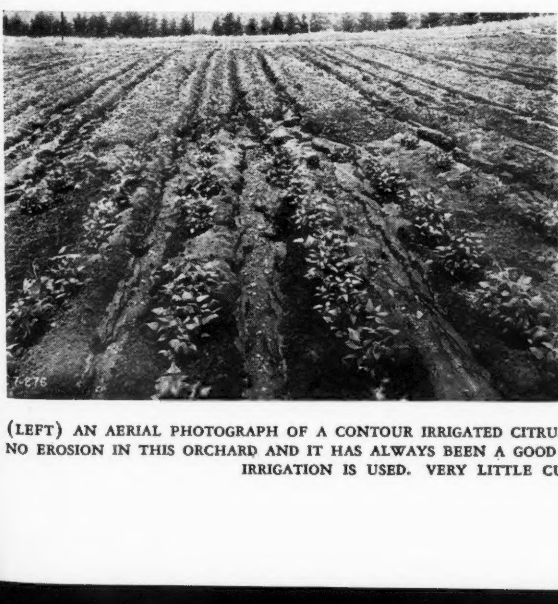

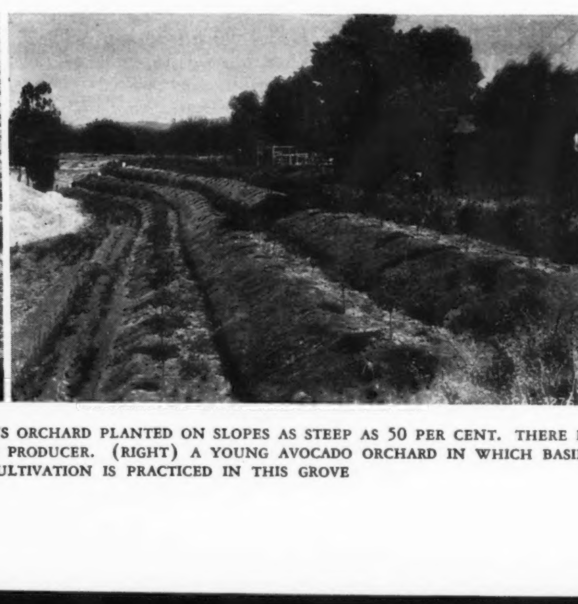

(LEFT) AN AERIAL PHOTOGRAPH OF A CONTOUR IRRIGATED CITRUS ORCHARD PLANTED ON SLOPES AS STEEP AS 50 PER CENT. THERE IS NO EROSION IN THIS ORCHARD AND IT HAS ALWAYS BEEN A GOOD PRODUCER. (RIGHT) A YOUNG AVOCADO ORCHARD IN WHICH BASIN IRRIGATION IS USED. VERY LITTLE CULTIVATION IS PRACTICED IN THIS GROVE

erosion on steep hillsides, and it is strongly recommended that, wherever water cost will permit, a winter cover crop be planted early in the fall and left until the last of the winter rains are over.

A cover cropping practice commonly followed in the West is to plant the seed soon after the late August or September irrigation and to leave the furrows throughout the rainy season. If early rains do not come as expected, the furrows will later serve for irrigation in growing the cover crop, which will provide sufficient protection to the soil, and leave any excess storm waters clear and free from silt as they run off the fields.

The exit of the water from the furrows, and particularly the point of exit where it enters a drainage channel, is important from the standpoint of erosion. The excess water from the furrows, whether it be waste water from irrigation or runoff water from a storm, must be taken care of by protected outlet channels. This will prevent serious cutting where the water drops from the fields into the main downdraft or natural drainage channel. These outlets, as well as the downdrafts themselves, require such types of permanent protection as the grade of the channel necessitates in order to prevent them from becoming harmful and dangerous gullies.

### IMPORTANCE OF PROPER LAYOUT

The importance of proper layout in the beginning on land that is rolling or of irregular topography cannot be overemphasized. Too frequently and too generally, the farmer lays out his land with straight lines for open field crops and with straight, rectangular plantings for his orchards. One of the first and perhaps most important axioms in the practice of soil erosion control is that wherever sloping or hillside land is to be farmed, it should be done on the contour or grade contour system regardless of whether it is to be irrigated or dry farmed. This axiom also applies regardless of the type of crop or whether the irrigation is to be by furrows, sprinkling, flooding, or basins. In other words, all tillage practices and crops on any but level land should be on the contour, or the proper irrigation contour.

In the course of fifteen years' experience in the layout of irrigation systems on sloping lands, a large number of examples of both good and bad practices have been noted and a few of them are worth citing at this time.

Near Uplands, in San Bernardino County, California, there is a lemon orchard which was first planted in 1895 on what we generally term "a contour system"; that is, the trees follow approximately true irrigation grade lines. That orchard is still owned and successfully cultivated by the same man who laid it out. While the topsoil may have shifted to some extent, it has remained in the orchard where it belongs, the trees have a good appearance, and crop records indicate satisfactory production.

Immediately surrounding this grove are other orchards that were laid out for irrigation down the steep part of the slope, but in many cases, due to excessive erosion, the original orchards have been replaced by new trees. However, in spite of such evidence, they are still being irrigated on grades that cause each succeeding irrigation to move substantial portions of the topsoil from the upper end of the farm to the bottom, if not entirely off the land.

At Chino, there is an orange grove of 208 acres consisting of several individually irrigated blocks planted on the alluvial fan of a side canyon, which has an average grade of 4½ per cent. Pipe lines were installed to run the irrigation water down this 4½ per cent slope; and even before reaching maturity the orchards began to decline in production, and the original owners were glad to sell to the present owner at a sacrifice.

With the help of technicians from the experiment station and the extension service, the new owner concluded that the decline in production of the orange grove was caused by the fact that the upper end of each block of the orchards had been seriously eroded. This was evidenced by irrigation stands and trees standing on mounds in the upper portions of the orchards, while the trees in the lower end of the orchards were literally buried under deposits of soil amounting to as much as 18 inches in depth.

### ERODED SOIL HAULED BACK TO HIGH GROUND

Three dump trucks and a tractor-loading device were purchased by the new owner, and the "wandering" soil was scooped up and returned to the upper portions of the orchards. New irrigation pipe lines were installed which provided for irrigation along the cross rows on a grade of approximately 1½ per cent. Within a few years nearly all the trees recovered and now have a uniform appearance over the entire 208 acres. The change in irrigation practices has practically eliminated further erosion.

The beneficial effects of returning the soil has been substantiated further by a comparison of yields. In the spring of 1935, a pick from each box row ran between 1000 and 1100 field boxes. The box rows followed the new irrigation rows and thus served as sample strips across the steep part of the slope, and the slight variation in the total number of boxes seemed to have no relation to the location of the rows in the orchard. In other words, the formerly eroded ends of the orchards now produce their full share of the crop.

A citrus and walnut orchard in Orange County may be used as another example. It was originally laid out and irrigated in such a manner that the irrigation grade was a contributing factor in the resultant erosion that occurred. The length of the irrigation runs was about 800 ft. Ten years ago the owner installed three new pipe lines, cutting the length of the irrigation runs to about 200 ft each. Since that time, he has been able to maintain a uniform distribution of water; and although he continues to irrigate on the same slope or grade as before, the size of each stream, and consequently the velocity of flow, has been so reduced that, with the aid of cover crops, very little erosion results from either irrigation or the winter rains.

There is a lima bean farmer in California who has boasted that he has run his irrigation water farther in his furrows than any one else in his county. This lima bean field contains 300 acres, and the maximum irrigation run is 4000 ft, with a grade of 1 to 2 per cent. His claim regarding the unusual length of his irrigation furrows has stood without contest for many years. Recently, however, we have been accorded access to levels and cross sections of land that were obtained in 1915; and now, twenty-two years after these levels were taken, we find, by checking them in the field with the same bench marks as used in the earlier survey, that this farmer has lowered the upper end of his land an average of 6 in or more. Unfortunately, we do not have any levels taken in the lower end of the same field in 1915 and, therefore, cannot estimate the amount of soil carried entirely away. However, it is interesting to observe that the farmer can no longer cross his buried pipe lines with plows or subsoilers.

Near King City in Monterey, California, there are several large ranches where the open field bean crops have been irrigated in runs averaging between 1000 and 2000 ft in length. Operators of these properties found that by packing the soil in the irrigation furrow they obtained less erosion and better distribution of water. The packing is accomplished by using an attachment which consists of a pneumatic automobile tire on which weights are placed and

(LEFT) EROSION CAN OCCUR ON IRRIGATED LANDS AS EVIDENCED IN THIS BEAN FIELD. THE GRADE WAS OBVIOUSLY TOO STEEP FOR THE LENGTH OF RUN AND ONE OR THE OTHER OR BOTH OF THESE FACTORS GOVERNING EROSION WILL HAVE TO BE CHANGED BEFORE THE FIELD CAN BE IRRIGATED WITHOUT DAMAGE. (RIGHT) A SMALL BENCH-TERRACED ORCHARD IRRIGATED BY FURROWS FROM THE WHITE IRRIGATION STANDS SEEN AT THE FAR END OF THE ROWS. NOTE THE PERMANENT VEGETATIVE COVER ON THE "RISERS"

CORRECTION: Due to a typographical error, the above caption and the caption of the illustration on page 531 were reversed.

which rolls immediately behind the cultivator. On starting out from the pipe line, the full complement of weights is placed on the tire, but they are gradually removed during the length of the run until the tire itself is lifted from the furrow at the lower end of the field. While greater penetration and more uniform distribution were the principal objectives in these experiments, erosion in the furrows was also recognized by the owners as being a serious problem, and it is believed that an effective control has been found.

In the foothill section of the Sierra Nevadas in California, lying in El Dorado, Placer, and adjoining counties, there is an important deciduous fruit belt, which supplies the markets with one-third of all this type of fruit produced in the state, and the major portion of these orchards is irrigated. These farm lands and orchards were developed following the gold rush days, and the present water companies operate under the same water rights established by the placer or hydraulic miners in the early days. When the orchards were laid out, apparently no thought was given to proper irrigation grades. They are, for the most part, square-planted, regardless of the fact that the topography is irregular and rolling. In general, the irrigation is down the steepest part of the slope and is done on grades ranging from 10 to 30 per cent. That this area cannot continue its high production much longer is evidenced by the entire absence of topsoil on the upper ends of many orchards and the deposition in lower portions.

Two problems in irrigation practices as a factor in soil erosion control are involved. One is that the grades used are uniformly too steep, with the result that the orchard land has been robbed by irrigation soil erosion of its topsoil in the upper parts of the orchards, while the lower portions have been seriously covered up. The second is that the irrigation companies allot the water by regulated, continual flow to each water user. Under this system, the orchardist starts irrigating at the beginning of the season and is faced with irrigation 24 hr a day throughout the entire summer.

Where open field crops are grown, the irrigation farmer in this district generally attempts to economize on the cost of installing pipe lines or other distributing methods and, therefore, is forced to use long runs or furrows. Each stream, when leaving the distributing head, must necessarily be large enough to reach the lower end of the run, and even though the grade may approach the ideal, nevertheless, there is a continual tendency to erode the upper portion of the field owing to the volume of water necessary to complete the run. If only the savings in water and the benefits from uniform distribution were given consideration, it is probable that, in many instances, the farmer could well afford to cut down the length of his runs by installing additional distribution lines and by so doing, largely eliminate the irrigation erosion problem.

It is also probable that additional benefit from the standpoint of erosion prevention would be effected if a sufficiently large head of water could be delivered to one farmer after another for a short period of time in order that he could complete his irrigation in a few days. In this way, it is likely that the farmer would pay more attention to the irrigation and the amount of water flowing in each furrow. At the present time, he merely changes the water and goes about his work without giving the irrigation another thought until the next day when it is again time to make the change.

In parts of the West, and especially in areas where avocados are raised, there is a growing use of the basin type of irrigation to remedy the erosion conditions caused by steep irrigation grades. The water flowing from basin to basin follows a zig-zag course in and around every tree instead of a straight furrow to the bottom of the hill.

Cultivation in the avocado orchards of southern California is very limited and, in many instances, not done at all. This makes it possible to maintain permanent basins around each tree where the slope is steep enough to make it necessary. Some orchards in San Diego County are actually laid out with a faucet under each tree that delivers water to the individual basin. One lemon grower has used this cultural and irrigation practice in his lemon orchard since 1923 and has found that the permanent basins prevent soil erosion. He places fertilizer directly in the basins. The walls of the basins are just outside the drip of the tree and are covered with a permanent sod cover. This irrigation practice has been effective not only in stopping all erosion damage, but a six-year record, from 1931 to 1936 inclusive, of 9.14 field boxes of 50 lb each per tree indicates that his production is considerably above the average of most of the other groves in his locality.

Irrigation water can be applied by sprinkling at a rate low enough to permit complete percolation, and thus erosion control is effected by the avoidance of irrigation runoff. Permanent overhead sprinkling systems have been used in southern California orchards for many years, although recent installations of sprinkling systems have usually been of the "under tree" type rather than the overhead system. The

development of satisfactory quick-coupling devices and the production of light-weight pipe in smaller sizes, makes practical and has encouraged a much wider use of sprinkling systems for irrigation. It is now economically feasible to use portable systems on open field and row crops, although the per-acre cost of installation may be more than for other methods of irrigation. It should be borne in mind that while sprinkling may prevent irrigation erosion, it offers no protection against storm water. Consequently, contour planting and cultivation or permanent cover crops with protected waterways should always be utilized on slopes, regardless of the irrigation system used.

Many orchards in the citrus and avocado districts of southern California have been planted on land having from 5 to 40 or 50 per cent cross slope. In order to farm these lands without damage from erosion, the owners have resorted to a practice which has been in use for centuries, or even thousands of years—that is, an adaptation of bench terraces wherein the trees are planted on flat terraces laid out on a suitable irrigation grade, with steep risers between each terrace protected by permanent cover crops.

### BENCH TERRACES FOR STEEP SLOPES

In many places and under certain favorable soil and subsoil conditions, bench terraces built before trees were planted have proved successful. In general, however, this method and the resultant disturbing of the soil has resulted in unfavorable tree growth or production. On the other hand, bench-terraced orchards which gradually developed by cultivation from trees set out on an irrigation grade, have been uniformly productive; and it is maintained that such a bench-terraced system is the best practice for horticulture on rolling, irregular, or steep land not only from the standpoint of soil erosion and its control, but from the standpoint of farm management as well.

The first important thing in laying out such contour, bench-terrace systems on a hillside is to make sure that there is no clay strata close enough to the surface to cause slippage. Other observations of the condition of the soil include the amount of topsoil, character and permeability of the subsoil, and depth to the parent material.

There is no practical rule-of-thumb or chart guide for the several variables to be considered in laying out such an orchard. In general, however, the irrigation runs should be short, with the steeper grades being compensated for by shorter runs. Two hundred feet is a satisfactory average, although in some cases 300 ft has proved safe. The irrigation grade must vary with the permeability of the soil and with the cross slope. In general, the steeper the cross slope, the steeper must be the grade of the irrigation furrows, starting with perhaps a minimum of 2 per cent where the cross slope is 10 per cent and ranging upward to 4 per cent on the steeper slopes.

After laying out a contour or grade line orchard, it is best to have two or three furrows thrown up along the tree rows before the trees are planted. This is beneficial in two ways, in that it permits planting the trees a little higher than the average slope, and it also leaves a furrow for irrigating the trees during planting. Afterwards, by cultivating in only one direction—that is, in the direction of irrigation—and by permitting no cross cultivation whatsoever, it has been found that a bench-terrace system will develop within less than ten years. The original spacing of the trees and rows must be so arranged that, when benches have finally developed, there will be sufficient room for cultivation and irrigation with four irrigation furrows between the tree rows.

Other conditions to be considered in connection with an orchard layout are source of supply and amount of irrigation water available, roads for hauling fruit and fertilizer, fumigation, size of farm, disposal of waste or storm water, and type of farm operator.

The irrigation grade is perhaps the most important single factor to be considered. Consequently, it is frequently determined by experiment before orchards are set out. In our work along this line, series of irrigation furrows were laid out on varying grades; and after a 48-hr run of water, all conditions of cutting or silting, depth of penetration, and lateral spread of water were noted. Frequently, a second application of water was made, extending over several days in order to simulate the effect of storm water. Such observations permitted the selection of an irrigation grade which not only provided uniform distribution of water, but also prevented all erosion. The wisdom of making decisions on the basis of such empirical methods has been proved by observations extending over 19 yr.

In summing up the various factors that influence successful irrigation from a standpoint of erosion prevention, it would seem that we cannot place too much importance upon the human equation and the limiting factor of crop return.

### FARM MANAGEMENT INFLUENCES

Certainly any successful farm management program involves and demands a substantial degree of intelligence on the part of the person or persons controlling the land. Granting that we have a high type of agriculturist here in the West, it is still quite evident that there is either a lack of knowledge or a more serious lack of desire to protect instead of exploit the soil. There is no obstacle of involved reasoning or mechanical precision to prevent the installation and successful operation of modern irrigation practices. It appears that the greatest need is for a wider and more sympathetic understanding of what should be done and why it should be done by the men in whose hands the land is entrusted. Land can be and is being farmed and irrigated without soil loss on the steepest practical slopes, and there is no scientific reason why the methods being used successfully in a few places today cannot be generally applied.

There is, however, a limiting economic factor that will undoubtedly retard the general adoption of certain known and tried methods. Sloping land of as high as 50 per cent can be and frequently is successfully planted to irrigated orchards without permitting soil loss from erosion, but such methods call for an expenditure of money that is all but prohibitive, except where the land is devoted to growing high-pay crops. It goes without saying that where land will return to the owner \$100.00 to \$300.00 per acre per year, the farmer will automatically expend considerable sums and labor to insure the permanency of the soil. However, if such extreme slopes are devoted to low-pay crops, methods involving bench terraces, costly drainage channels, and other expensive control measures will automatically be barred.

The question then arises, Should not lands devoted to such low-pay crops that they cannot support erosion control measures be retired from cultivation until needed for a more remunerative crop?

The answer to this question would undoubtedly banish our problem child, but the youngster is entirely too lusty to be removed so simply and easily. Nevertheless, we believe that if the agencies and the people in charge of irrigation districts involving sloping lands gave more thought to the solution of this problem, there would be far fewer irrigation districts defaulting on their bonds.

Generally, it may be said in conclusion that the greatest need today in the field of irrigation is for a wider and more comprehensive educational program, designed to bring about a consciousness of erosion as an everpresent destructive factor to be reckoned with by those who have our irrigated hillsides in their care.

# Instruction in Rural Electrification

By Truman E. Hienton

THE youngest member of the agricultural engineering family, rural electrification, is growing up—growing up so rapidly that today there are probably as many farms in the United States with electric service as there are with tractors. To the casual observer this statement may sound erroneous but careful examination of the available figures will verify it.

This discussion is not intended to compare the relative merits of electric and tractor power, for they are seldom in competition, but to ask whether a rural electrification course or courses may not be as important as one or more tractor courses to the agricultural engineers and agricultural students now enrolled in agricultural engineering classes. Nearly every college agricultural engineering department is now teaching one or more tractor courses.

The need for rural electrification courses will depend upon the location of the university with respect to rural electrification development. The percentage of agricultural engineering students in university classes, living on farms where electric service is available, will be surprising to many instructors when they seek that information. More than fifty per cent of the winter course (8 weeks) students in agriculture at Purdue University this past winter lived on farms where electricity was used. Checks on four-year students showed an even higher percentage living on electrified farms. This situation existed, although only 26.7 per cent of Indiana farms receive electric service from rural lines.

It may be advisable for instructors to ascertain what percentage of the members of their classes do live on farms where electricity is used. A check by the chairman of this division, of the agricultural engineers in his power and machinery courses during the past spring quarter, revealed that 35 of 46 students, or 76 per cent, came from electrified farms. Yet the percentage of electrified Iowa farms is less than one-fourth that amount, 18.5 per cent. H. W. Riley of Cornell University has advised that of a class of 90 students taking the electric course there during the spring of 1938, 87 per cent of those who lived on farms had electric service.

Agricultural engineers engaged in instructional work must consider whether the material they are teaching is appropriate for their students if they should find conditions among them similar to those in New York, Iowa, and Indiana. Two rather pertinent points may be raised under such conditions. The first is whether the confidence of students will be retained if present courses are not rearranged to include more instruction in electricity and electrical equipment or new ones provided on the subject. The second point is whether agricultural engineers wish to teach rural electrification courses or turn them over to other departments.

There should be general agreement on the fact that student interest in agricultural engineering courses will decrease unless a certain amount of attention is given to the use of electricity. Students who have been accustomed to using electric motors at home, will not be satisfied with farm power and equipment courses which do not include some material of an electrical nature. The exact method to be followed will vary widely, but in general it should not be difficult to include a certain amount of work in nearly every agricultural engineering course pertaining to electricity and electrical equipment. Certainly farm power and machinery courses should at least recognize the present and potential use of the electric motor as a power unit and the equipment which it may drive. One department introduces certain electrical material in its degree course in rural architecture and also in the pump irrigation phase of reclamation engineering.

At colleges and universities where a degree course is offered in agricultural engineering, there should be at least one and possibly more courses in rural electrification in addition to the farm power, farm machinery, and farm utilities courses. The day is rapidly passing when a farmer obtains "lights" with the extension of an electric line to his farm. Power applications of electricity are forced to share the spotlight of his attention with applications of electric heaters. Incubators, chick brooders, water heaters for poultry, dairy and livestock drinking fountains, pig brooders, and heaters for sweet potato and tobacco storage houses are now electrically energized. Electric radiation for stimulating plant growth for irradiation of livestock and poultry, and for attraction of insects are subjects about which future agricultural engineers should know. Material of the type mentioned could be organized into one or more courses in *rural electrification*.

Certain reasons have already been presented for the necessity of such a course or courses. A more potent reason and one of vital importance to all such departments is the potential demand for men with such training. One department reports that 22 per cent of its graduates are now engaged in rural electrification work, a total of 31 men. Other departments report from 2 to 10 men engaged in such work. The potential demand for agricultural engineers with rural electrification training is difficult to forecast but will definitely increase. Utilities, both public and private, manufacturers of electrical equipment and their representatives, and the three-part college field of teaching, research, and extension will have greater needs for men trained in rural electrification in the near future.

Acceptance of the need for teaching rural electrification to agricultural engineers and nondegree students is presumed in discussing by whom the work shall be taught. Degree courses include, in all known cases, at least one and as many as three courses in electrical engineering. Such courses should provide the foundation on which rural electrification courses are built, just as mathematics, physics, and mechanics are steps toward the other phases of agricultural engineering—farm power and machinery, farm structures, and soil and water conservation. In the same way, agricultural engineers should teach the rural electrification courses as they do the other phases of agricultural engineering.

Service courses in rural electrification for agricultural students are already being taught in eight colleges and universities, seven by agricultural engineering departments and one by the electrical engineering department. As far as can be determined there are three institutions which offer a rural electrification course to the agricultural engineers in its degree course. Here should be the first demand for agricultural engineers with rural electrification training, in the field of college teaching.

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Presented before the College Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 27, 1938.

Author: Associate in agricultural engineering and in the agricultural experiment station, Purdue University. Mem. A.S.A.E.

# What Agricultural Engineers Are Doing

FROM THE U. S. BUREAU OF AGRICULTURAL ENGINEERING

STUDIES of corn storage in farm cribs are being made in three counties in Iowa; two in Minnesota; three in Illinois and two in Indiana. Some 20 to 25 cribs in each county will be carefully examined and the corn sampled at intervals throughout the winter. This work is being conducted by Messrs. Barre, Cleaver, and Swanson and their assistants, in cooperation with the agricultural engineering departments of the universities and the agricultural conservation committees of the four states.

Experimental storage tests are going on at Ames, Iowa, and Urbana, Ill., in cooperation with the experiment stations. At Ames the equipment under investigation includes a large double corncrib used last year and seven prefabricated steel cribs loaned by manufacturers. At Urbana, experiments are being conducted with the weighable 300-bu cribs used in previous experiments. At both of these stations and at Fargo, North Dakota, Cadillac and Paw Paw, Michigan, College Park, Maryland, and Athens, Georgia, data on drying rates and equilibrium moisture of corn are being obtained using groups of ears individually exposed in shelters. The data obtained from these studies and from observations obtained in the county studies referred to above will be correlated with weather data obtained from 30 or more airway stations of the Weather Bureau. One use that may be made of these data is the preparation of maps showing the influence of weather upon the equilibrium moisture content and drying rate of corn in the various corn growing sections at different seasons.

* * *

Miss Juliette Mayer has been temporarily employed by the Bureau at Madison, Wisconsin, to study the effect of farmhouse remodeling upon the use made of the house by the family. Miss Mayer will work in close cooperation with Max J. LaRock of the agricultural engineering department and Miss Cowles of the home economics department of the University of Wisconsin.

* * *

After five years the roof covering of the canvas-covered buildings at Beltsville in many places needs replacing, but wall coverings are in general in good condition. Some of the treatments had not prevented moisture from entering and causing decay of the canvas. The panels have not been painted since originally installed.

* * *

Raymond B. Mitchell has recently been appointed to assist J. W. Simons in the farmhouse project at Athens, Georgia, for the winter tests.

* * *

Lewis A. Jones visited J. T. Olsen at Greenwood, Miss., where Mr. Olsen recently began investigations of the drainage districts of the state. He also visited F. E. Staebner in New Orleans and B. O. Childs at Lafayette, Louisiana, in connection with their work in irrigation and the operation of the CCC camps in Louisiana.

* * *

## Contributions Invited

*All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.*—EDITOR.

## Authors

*Earl L. Arnold* and *Deane G. Carter* are co-authors of "Storm Cellars," a new leaflet of the Arkansas Agricultural Extension Service and the U.S.D.A., cooperating. Mr. Arnold is also one of the authors of "The Trench Silo," Extension Circular No. 390, and sole author of "Homemade Homes," Extension Circular No. 413 and "Water Systems for the Farm Home," Extension Circular No. 416 of the same services.

*H. B. Roe* discusses "The Outlet Problem in Farm Drainage" in Agricultural Engineering News Letter No. 80, of the Agricultural Extension Division, University of Minnesota.

A study of the irrigation requirements of the eastern humid areas of the United States has recently been inaugurated in cooperation with the Weather Bureau and with the aid of WPA funds. F. E. Staebner has recently returned from New Orleans where he spent five weeks in directing the start of the work.

* * *

Good weather conditions made possible the continuation of peak production in the CCC drainage camps throughout October. Accomplishment for the month shows a total of 4,980,921 sq yd of clearing, 1,873,465 cu yd of excavation and embankment, 30,510 lin ft of tile reconditioning, and structural and miscellaneous maintenance work with expenditure of 107,999 man-days.

* * *

In October, a demonstrational tour of a truck excavator, low-cost ditcher for small drainage channels under development in the Central District CCC, was conducted on work projects of northern Indiana drainage camps. The demonstrations were arranged through the camp superintendents at Monon, Frankton, Lebanon, Valparaiso, South Bend, and Fort Wayne, by D. A. Isler, in charge of machinery development work in the district and D. H. Harker, collaborator with the Purdue University Extension Service.

The demonstrations given after a three-day trial run at each location were attended by county agents, surveyors, and commissioners, as well as local farmers, numbering from 20 to 80 in attendance at each demonstration. Particular interest was shown in the unit for use in maintenance work on small ditches handled in that area on the allotment cleanout plan and for shoal removal in larger ditches. The demonstrations also provided opportunity for study of the unit under a wide range of operating conditions varying from the peat land near South Bend to the sticky clay soil near Lebanon, and as a result, improvements are underway to overcome minor difficulties encountered.

The unit consists of a gas-driven double-drum motor hoist mounted on 1½-ton truck chassis, and fitted with a light 25-ft detachable boom for return of specially designed scrapers of 4 to 5 cu ft capacity. Results thus far indicate excavation cost under average conditions will range from 20 to 30 cents per yard. Approximate cost of the unit is $900, exclusive of the truck.

* * *

A conference of superintendents and engineers of the southeast Missouri drainage camps was held at New Madrid, Missouri, Oct. 20-22. In addition to the presentation of numerous technical papers by various camp personnel, the meeting was addressed by J. C. Wooley, head of the department of agricultural engineering, University of Missouri, and H. H. Kusekoph, professor of soils, also of the University of Missouri, as well as the District Engineer, John G. Sutton, and State Drainage Inspector, Clark E. Jacoby. The meeting was attended by approximately 50 local, county, and drainage district officials and landowners.

* * *

A. T. Mitchelson returned to Berkeley November 2 from Washington, D. C., where he consulted with George R. Boyd and with officials of the Office of Experiment Stations, the Soil Conservation Service, the Bureau of Plant Industry, and others, regarding work of the division of irrigation. Enroute to Washington he conferred with O. W. Israelsen at Salt Lake City and with Forest Service officials at Ogden. He also met M. R. Lewis and Dean C. Muckel at Scottsbluff, Nebr., and discussed with them and with the Superintendent of the Scottsbluff Station, the future cooperative work at the Station. On his return trip he conferred with Harry G. Nickle at Austin, Texas and with Harry F. Blaney at Los Angeles.

* * *

R. L. Parshall prepared a design for a model riffle deflector vortex tube sand trap to be tested at the Bellvue laboratory, Colorado, to obtain data needed in designing a similar sand trap for use in the New York Canal of the Boise project, which has a capacity of 2,800 sec ft. The model will be about 7 ft long and will be installed in a section of canal 30 ft long, having a discharge of 15 sec ft.

* * *

A conference of workers of the division of irrigation engaged in snow survey and irrigation water supply forecasting was held at Salt Lake City, Utah, October 17, those present being J. C. Marr, R. L. Parshall, R. A. Work, Geo. D. Clyde, O. W. Monson, Carl Elges, L. T. Jessup and Paul A. Ewing. Plans for the work of the coming winter were discussed and the text of a "Snow Survey Manual" prepared by Mr.

*(Continued on page 542)*

# NEWS

## Southern Section to Participate in Nutrition Program

"PROBLEMS in Plant, Animal, and Human Nutrition as Related to the Social and Economic Life of the South", is the announced theme for the annual meeting of the Association of Southern Agricultural Workers, to be held at New Orleans, February 1-3, 1939. The Southern Section of the A.S.A.E., meeting in conjunction with that organization, has announced a program designed to fit into the same theme.

Four sessions of the Section are planned, in which attention will be given successively to soil and water conservation, power and machinery, rural electrification, and farm structures.

Features of the conservation session, G. E. Martin presiding, will be an address by S. P. Lyle, president of A.S.A.E.; "Engineering Uses of AAA Aerial Photography," by C. J. Hutchinson; "The Place of Engineering in Soil and Water Conservation," by V. R. Hillman; and "Plant Nutrient Deficiencies from Erosion and Their Social Effects," by M. L. Nichols. J. H. Nicholson will lead the discussion.

In the power and machinery session, at which V. R. Hillman is to preside, the subjects and speakers tentatively scheduled are "King Cotton's American Throne," by J. W. Firor; "Problems in Connection with County Association Power Unit Terracing Program, and Suggested Solutions," by John W. Carpenter; "Terracing by Contract," by J. T. Copeland; and "Some Needed Engineering Developments in Southern Farm Machinery," by H. P. Smith. Discussion of these papers will be led by C. V. Phagan.

M. M. Johns will preside at the rural electrification session, featuring papers on "The Rural Market for Electrical Output," by Oscar W. Meier; "After Agricultural Engineering Research—What"? by C. J. Hurd; "Extending Electricity from the Farm Home," by D. S. Weaver; and "Community Refrigeration Development: Its Social and Economic Effects," by George Rietz. C. L. Osterberger is slated to lead the subsequent discussion.

A round table on rural electrification is also scheduled for one evening during the meeting.

The farm structures session, with R. H. Driftmier presiding, will offer papers on "An Agricultural Engineering Curriculum to Fit Present Day Demands," by Dr. Paul W. Chapman; "Progress of the Farm Building Plan Service," by Wallace Ashby; "Farm Housing Research Pointers," by J. W. Simons; and "Structures Problems Affecting Nutrition as Related to the Economic Life of the South," by Mr. Driftmier. M. A. Sharp has the assignment of leading discussion.

A business session of the Section is scheduled in connection with a breakfast at 8 a. m., February 2.

## Schaenzer Addresses Wisconsin Utilities Association

J. P. SCHAENZER presented a paper entitled "Electricity Increases Farm Profits," before a convention of the Electric Section of the Wisconsin Utilities Association, held in Milwaukee, Wis., October 24.

## Index to Volume 19

The index to AGRICULTURAL ENGINEERING, Vol. 19, 1938, has been completed and is being mailed with this issue to all members and subscribers.

## C.R.E.A. Meeting Papers

PAPERS presented at the fifteenth annual meeting of the Committee on the Relation of Electricity to Agriculture and since made available in mimeograph form include the "Fifteenth Annual Report" by the Director (Dr. E. A. White); "The Engineering Analysis Approach to Our Farm Problems and Its Many Possibilities," by S. B. Darnell; "Engineering Analysis of Five Rural Lines" of the Alabama Power Company; "An Engineering Analysis of Forty Customers on a Rural Line of Wisconsin Power and Light Company," by E. R. Meacham and J. P. Schaenzer; and "Consumption, Costs, and Uses of Electricity on New York State Farms," by W. E. Keepper.

## Washington News Letter

*from* AMERICAN ENGINEERING COUNCIL

### ANNUAL ASSEMBLY, AMERICAN ENGINEERING COUNCIL

THE Assembly of Council at the Mayflower Hotel, Washington, D. C., January 12-14, 1939 will sponsor a series of public discussions or forums, two of which have already proved so successful in Philadelphia and Detroit. The general theme of these series of forums will be the interrelation between the engineer and major social and economic questions of the day in the melting pot of national consideration at the moment. The first two days of the program will be devoted to a series of four public discussions. The subjects at present agreed upon include, "The Economic Status of the Engineer", "The Limits of Size to Industrial Expansion", and "The Engineering Factors in National Planning."

### SOCIAL INVENTION MUST KEEP PACE WITH TECHNICAL INVENTION

Some 200 industrialists, heads of research departments, patent lawyers, and engineers, engaged in a spirited discussion of "Invention and the Engineers' Relation to It" at the Second Forum of American Engineering Council, held in Detroit, November 11, at the Hotel Statler, with the Michigan Engineering Society acting as host. The formal papers presented at this meeting, together with the discussion, will be printed and distributed as a supplement to the December Bulletin of American Engineering Council.

The forum, in subject and in time, was scheduled so that the viewpoint of the engineering and allied professions might be expressed with regard to invention as a contribution to the hearings which, it is expected, will be held in Washington during December, under the direction of the so-called Temporary National Economic Committee, sometimes called in brief the "Monopoly Committee." It will be recalled that Senator O'Mahoney, the chairman of this committee, made a vigorous plea for the federal incorporation of business enterprise, at the annual meeting of American Engineering Council in Washington in January, 1938.

The purpose of this forum, as in the case of the first forum, which was held in Philadelphia, and of the others which are to follow is to provide, first, a series of basic papers on the several factors involving the subject and, second, discussion both by members of the engineering profession and of the allied professions and representatives of the public, in such a way that the combination may be considered a contribution to the public good. The success of the two forums, both in the character of the papers, the high quality of the discussion and in the interest shown by those in attendance, indicates that the forum plan has a distinct place as an instrumentality in providing a means of assembling and distributing opinion on topics of national interest to which the engineer is related, both as a technical expert and a citizen.

The presentation of the papers and the discussion which resulted indicated that there were three groups of interest in this field of "Invention and the Engineers' Relation to It"; namely, the public, the inventor, and the business which makes use of the invention. The public interest is evident in the fact that invention creates new products, new processes, new methods and thereby creates social and economic questions paralleling the development of industry. In the second place, it was made clear that invention can only be fostered by stimulating and rewarding the inventor since an invention is an "intellectual property," and in various countries, various systems of protecting and rewarding the inventor have been developed. This led to a discussion of the American patent system and its advantages and disadvantages as a method of protecting "intellectual property." In the third place, the papers and the discussion developed the thought that invention today is one of the end products of scientific and technological research, that a long period of time may often elapse between the germ of an idea and the culmination of the fruits of the invention in terms of a manufactured product. The several phases of this were explored both by representatives of research agencies and by representatives of industry.

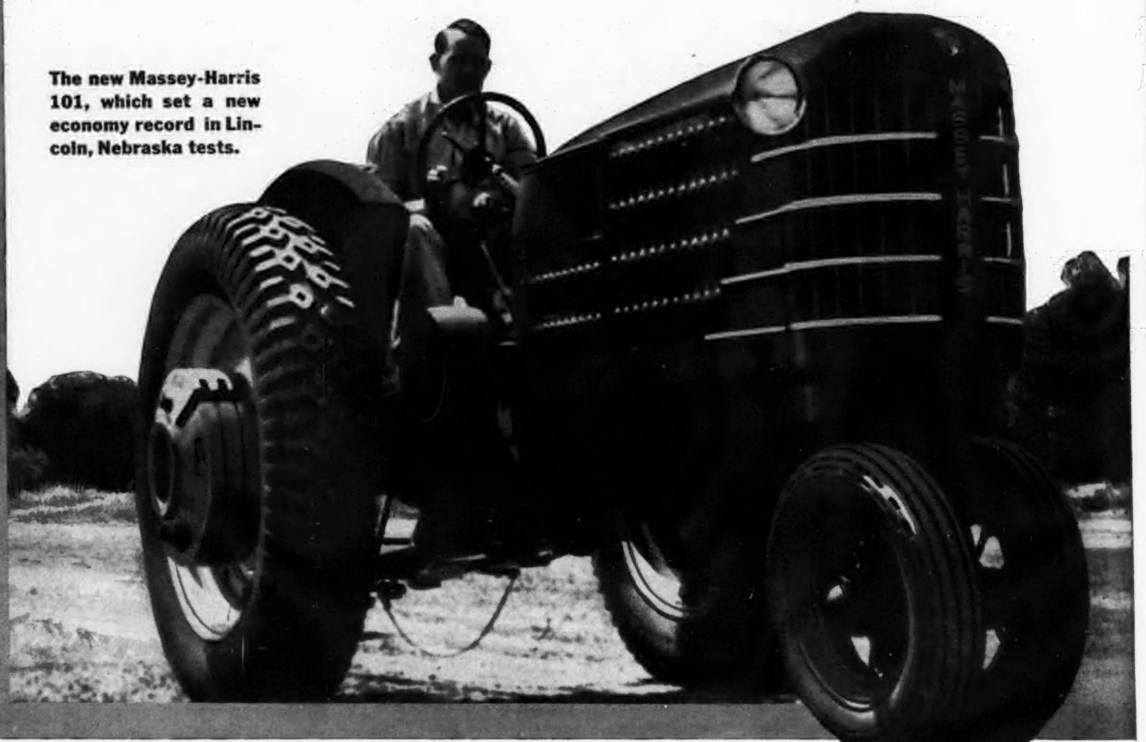
*(Continued on page 542)*

## ASAE Meetings Calendar

February 1-3, 1939—Southern Section, New Orleans, La.

June 19-22, 1939—Annual meeting, University Farm, St. Paul, Minn.

# GASOLINE



The new Massey-Harris 101, which set a new economy record in Lincoln, Nebraska tests.

**UNIVERSITY OF NEBRASKA—AGRICULTURAL ENGINEERING DEPARTMENT**
**AGRICULTURAL COLLEGE, LINCOLN**

Copy of Report of Official Tractor Test No. 307
Dates of test: September 9 to 30, 1938.
Name and model of tractor: *MASSEY-HARRIS "101" R*
Manufacturer: Massey-Harris Company, Racine, Wisconsin.
Manufacturer's rating: NOT RATED.

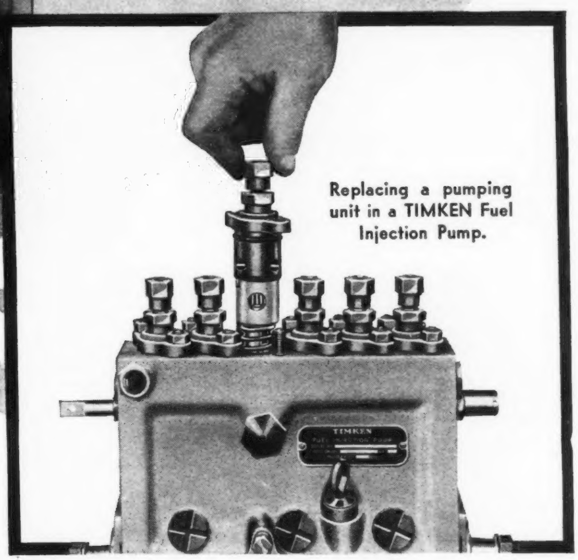
**BELT HORSEPOWER TESTS**

| H.P. | Crank-shaft speed R.P.M. | Fuel Consumption: Gal. per hr. | Fuel Consumption: H.P. hr. per gal. | Fuel Consumption: Lb. per H.P. hr. | Water used gal. per hr. | Temp. Deg. F.: Cooling med. | Temp. Deg. F.: Air | Barometer Inches of Mercury |
|---|---|---|---|---|---|---|---|---|
| **1500 R.P.M.** | | | | | | | | |
| **TEST B—100% MAXIMUM LOAD—TWO HOURS** | | | | | | | | |
| 35.40 | 1500 | 3.105 | 11.40 | 0.541 | 0.000 | 181 | 69 | 29.010 |
| **TEST C—OPERATING MAXIMUM LOAD—ONE HOUR** | | | | | | | | |
| 34.10 | 1500 | 2.880 | 11.84 | 0.521 | 0.000 | 182 | 71 | 29.010 |
| ***TEST D--ONE HOUR** | | | | | | | | |
| 31.40 | 1500 | 2.775 | 11.32 | 0.545 | 0.000 | 182 | 75 | 29.015 |
| **TEST E—VARYING LOAD—TWO HOURS (20 minute runs; last line average)** | | | | | | | | |
| 31.21 | 1495 | 2.737 | 11.40 | 0.541 | — | 184 | 76 | — |
| 1.16 | 1655 | 1.361 | 0.85 | 7.241 | — | 157 | 74 | — |
| 16.36 | 1558 | 1.945 | 8.41 | 0.734 | — | 167 | 75 | — |
| 32.34 | 1424 | 2.733 | 11.83 | 0.522 | — | 184 | 77 | — |
| 8.45 | 1614 | 1.677 | 5.04 | 1.225 | — | 162 | 76 | — |
| 23.91 | 1521 | 2.305 | 10.37 | 0.595 | — | 171 | 75 | — |
| 18.91 | 1545 | 2.126 | 8.89 | 0.694 | 0.000 | 171 | 75 | 29.020 |
| **1800 R.P.M.** | | | | | | | | |
| **TEST B—100% MAXIMUM LOAD—TWO HOURS** | | | | | | | | |
| 40.67 | 1800 | 3.649 | 11.15 | 0.553 | 0.000 | 183 | 76 | 29.010 |
| **TEST C—OPERATING MAXIMUM LOAD—ONE HOUR** | | | | | | | | |
| 38.65 | 1802 | 3.313 | 11.67 | 0.529 | 0.000 | 183 | 79 | 28.910 |
| ***TEST D—ONE HOUR** | | | | | | | | |
| 36.34 | 1800 | 3.253 | 11.17 | 0.552 | 0.000 | 184 | 81 | 28.895 |
| **TEST E—VARYING LOAD—TWO HOURS (20 minute runs; last line average)** | | | | | | | | |
| 36.36 | 1796 | 3.243 | 11.21 | 0.550 | — | 185 | 81 | — |
| 1.36 | 1948 | 1.585 | 0.86 | 7.191 | — | 157 | 79 | — |
| 18.81 | 1866 | 2.241 | 8.39 | 0.735 | — | 166 | 79 | — |
| 37.92 | 1750 | 3.248 | 11.67 | 0.528 | — | 180 | 79 | — |
| 9.66 | 1907 | 1.911 | 5.05 | 1.220 | — | 161 | 76 | — |
| 27.83 | 1844 | 2.781 | 10.01 | 0.617 | — | 171 | 77 | — |
| 21.99 | 1852 | 2.502 | 8.79 | 0.702 | 0.000 | 170 | 78 | 28.870 |

*Formerly called RATED LOAD; see REMARKS 4.

**DRAWBAR HORSEPOWER TESTS**

| H.P. | Drawbar pull pounds | Speed miles per hr. | Crank-shaft speed R.P.M. | Slip on drive wheels % | Fuel Consumption: Gal. per hr. | Fuel Consumption: H.P. hr. per gal. | Fuel Consumption: Lb. per H.P. hr. | Water used gal. per hr. | Temp. Deg. F.: Cooling med. | Temp. Deg. F.: Air | Barometer Inches of Mercury |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **RUBBER TIRES** | | | | | | | | | | | |
| **TEST F—100% MAXIMUM LOAD—Third GEAR** | | | | | | | | | | | |
| 31.50 | 2487 | 4.75 | 1501 | 5.34 | Not Recorded | | | | 182 | 68 | 28.750 |



## Washington News Letter

*(Continued from page 537)*

CONDIT PRESENTS SOCIAL AND ECONOMIC BACKGROUND

Dean C. J. Freund of the University of Detroit, as chairman of the afternoon session of the forum, introduced in turn President Dirks of the Michigan Engineering Society, who welcomed those in attendance in the name of the Michigan Engineering Society, and expressed his belief in the purposefulness and the value of the forums. Next, F. A. Allner, chairman of the public affairs committee of the American Engineering Council, presented the broad purposes of the forums and outlined briefly the place of American Engineering Council in sponsoring them. The first formal discussion was presented by Kenneth H. Condit, assistant to the president of the National Industrial Conference Board.

Mr. Condit concluded: "Our Constitution is an invention. Our form of government is an invention. Our whole livelihood and standard of living is based on inventions. It may be that mechanical invention has outrun social invention, but so long as we keep alive within us the spirit of invention our chances for survival as a nation are bright."

THE PLACE OF GOVERNMENT IN RESEARCH

Dr. Lyman J. Briggs, Director of the National Bureau of Standards, took as his definition of research, the classification as presented by Julian Huxley in his book, "Science and Social Needs." He divided research into four categories: (1) background research with no practical objective consciously in view, such as atomic physics; (2) basic research, which must be fundamental in character but has some distant practical objective such as the study of fluorescence with the distant possibility of producing cold light; (3) ad-hoc research, with an immediate objective like research on discharge tubes for lighting purposes; and (4) development or engineering research, which is the work needed to translate laboratory findings into full-scale commercial practice.

THE CONFERENCE CONCLUDES

The Chairman, Dr. William McClellan, closed the conference by summarizing briefly the high spots of the meeting. He outlined his belief that the type of discussion that had been held was truly professional in character, that it was especially notable that there had been present during the discussion, not only representative engineers and industrialists but members of the professions of law, of economics, and of teaching.

The detailed arrangements for the meeting were in the hands of E. L. Brandt, executive secretary of the Michigan Engineering Society.

MAPPING

Evidence continues to accumulate as to the need of an adequate mapping program. Col. C. H. Birdseye, president of the Washington Society of Engineers, stated in a recent address:

"I spent two months of last summer in England, Holland, Germany and France largely in connection with the International Geographical Congress at Amsterdam. I found that all of these countries are completely covered by contour maps of the same general type as those that are being prepared in the United States, except on larger scales. Moreover England, although only about the size of New York and Pennsylvania combined, is spending annually more than twice as much on the revision of existing maps, as we are spending annually on new topographic mapping of all of the United States."

The so-called Hayden-Ickes plan for a coordinated ten-year mapping program still requires Budget Bureau and Congressional action to be made a reality, although every agency allied to mapping has expressed belief in the value of the plan, in which the Surveys and Maps Committee of American Engineering Council acted in an advisory capacity, and which has been recommended as in the public interest by the Assembly of American Engineering Council.

## What Agricultural Engineers Are Doing

*(Continued from page 536)*

Marr was reviewed. Arrangements have been made for cooperation with the State Engineer of Montana and the Montana Agricultural Experiment Station in snow survey work during the coming winter.

* * *

Dean C. Muckel completed his work in connection with a study of irrigation possibilities in South Dakota, and returned to Pomona, Calif., October 15. He is now assisting Harry F. Blaney in gathering data for a report on Los Angeles River Flood Control.

* * *

M. R. Lewis made an examination of the drainage problem on the Smith Valley Soil Conservation District in Lyon County, Nevada, where some 10,000 or 12,000 acres of land are either already affected by high water table or alkali or are seriously threatened with these evils. Mr. Lewis recommended that an investigation be made to determine what drainage should be undertaken and its cost.

* * *

Harry F. Blaney represented the Bureau at the regional board meeting of Region 10 of the Soil Conservation Service at Reno, Nevada, on October 4. The subject of soil conservation districts in California and Nevada was discussed, and it was stated that several areas in California had considered forming districts. The water facilities program also was discussed in some detail. A trip was made to the Walker River project of the Soil Conservation Service, in southern Nevada. Here the problem seems to be primarily a high water table caused by seepage from unlined canals built in porous material, resulting in accumulation of alkali. The difficulty probably can be overcome by combining the several small diversion canals into one large canal and lining it.

* * *

Mr. Blaney also attended a meeting of the Committee on Water Supply, Irrigation, and Drainage for Los Angeles County, which committee is sponsored by the Agricultural Extension Service of the College of Agriculture, University of California. Use of saline waters for irrigation was discussed, as well as contamination of irrigation supplies by percolating saline waters from higher lands, and by industrial wastes. A sub-committee was appointed to study the situation and make recommendations as to ways and means of having a survey made by federal, state and local interests.

* * *

Wells A. Hutchins conferred with Charles R. Brannan, regional attorney, Office of the Solicitor, Denver, Colo., concerning the study of western water laws which Mr. Hutchins has been carrying on for several months in cooperation with the Office of the Solicitor. He was also called upon to consult with the Legislative Committee of the South Dakota Reclamation Association, at Rapid City, S. D., concerning proposed irrigation legislation in that state. The committee is desirous of setting up a board or commission to further reclamation, and of providing for the formation of districts authorized to issue revenue bonds.

* * *

Colin A. Taylor reports progress in making the broad-furrow method of citrus orchard irrigation applicable in difficult situations. In making side-hill or contour furrows, blades of the folding wings of the furrowing machine were adjusted to the contour of the land. The machine was also demonstrated for making furrows with a full offset—two furrows to the right or two furrows to the left. In order to accomplish this, the necessary traction was obtained to hold the offset by using discarded automobile tires of the jumbo balloon type, filled three-fourths full of water. This greatly improved the grip on the soil. There are a number of old orchards in the vicinity of Pomona, Calif., where erosion has been so bad that the trees are now on mounds a foot or more above the furrow panel. In such cases furrows cannot be placed close to the trunks, and cross furrows are required for adequate irrigation. Ten acres of this type were cross-furrowed with broad furrows and blocked out for the cross-blocked method of irrigation. Straight furrows have been found more practical wherever they may be used. Cross-blocking is for special cases.

* * *

Homer J. Stockwell was appointed junior irrigation engineer and reported for duty at Pomona, Calif., October 1. He will assist Colin A. Taylor and John O. Reeve in field and laboratory work in connection with studies of the irrigation of subtropical fruit.

* * *

In a recent field trip covering all the field activities of the division of mechanical equipment of the Bureau of Agricultural Engineering, R. B. Gray made his first stop at Auburn, Ala., where he conferred with R. M. Merrill and his coworkers regarding future plans on the project. Extending tillage studies to several different soil types, mainly on substations of the Alabama Agricultural Experiment Station, is contemplated.

* * *

In Louisiana Mr. Gray, in company with E. D. Gordon, visited a number of sugar cane growers and inspected a cane windrower as well as a cane harvester.

* * *

At the starch plant at Laurel, Miss., he found that considerable machinery work appears to be necessary to mechanize sweet potato growing on a large scale. J. W. Randolph made good progress in adapting an Irish potato digger to digging sweet potatoes, work started by W. M. Hurst last year. In mechanization considerable difficulty is encoun- *(Continued on page 544)*

*Plow Discs permanently*

# PROTECTED AGAINST BREAKAGE IN SERVICE

*. . . through the development of a special NICKEL ALLOY STEEL*

*Illustration above shows tractor plow equipped with discs of SAE 3160 Nickel-chromium steel made by Ingersoll Division of Borg-Warner, New Castle, Ind.*

**STONES, some as large as a man's head, embedded a few inches below the surface, soon can work havoc with ordinary plow and harrow disc materials. In tests conducted under such conditions by the Ingersoll Steel and Disc Division of Borg-Warner Corporation, carbon steel discs even though made and heat-treated by the special Ingersoll process, tended to tear and break.**

**After extensive field and laboratory tests of various compositions, a Nickel alloy steel developed by the company proved most suitable. This material, "Super-Alloy", corresponds to SAE 3160, containing 1 to 1½% Nickel, 0.45/0.75% chromium and 0.55/0.65% carbon.**

**A demonstration of its superiority was recently made when a harrow disc plow came to the manufacturer's attention with 15 of its 16 discs broken. Analysis brought to light that the 1 survivor was made of "Super-Alloy", the composition containing Nickel.**

**We invite consultation on the use of the Nickel alloy steels and other Nickel alloys in your equipment.**

**AVERAGE PROPERTIES OF "SUPER-ALLOY"**

| | |
|---|---|
| Yield Point | 220,000 lbs. sq. in. |
| Ult. Tensile Strength | 225,000 lbs. sq. in. |
| Elongation | 6% |
| Reduction of Area | 20% |
| Rockwell (C) hardness | 47 |

# NICKEL ALLOY STEELS

**THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.**

## What Agricultural Engineers Are Doing

*(Continued from page 542)*

tered because of numerous pine stumps left in the fields. A general stump clearing program would materially facilitate machinery development.

* * *

At Davis, Calif., Mr. Gray attended the one-day conference of the U. S. Beet Sugar Association committee at which Messrs. McBirney and Mervine were also present. Future plans were discussed with these men, both at Davis and later with Mr. Mervine in Fort Collins. A summary of the single-seed planter, mechanical blocking and thinning, and beet harvester work for the past six months was given and general programs for the coming year presented.

* * *

At Logan, Utah, Mr. Gray discussed the weed control project with E. M. Dieffenbach and members of the station staff. In that state wild morning glory is public enemy No. 1, with white top a close second, and sow thistle third. In addition to the development of suitable equipment, mechanical or electrical, community cooperation is important. This latter is being accomplished by county organizations.

* * *

The corn production work at Ames, Iowa, was discussed with C. K. Shedd, Dr. J. B. Davidson and others. Field pickers were observed in operation, including an experimental picker developed cooperatively by this Bureau and the station. Observations were also made of the laboratory and field equipment being used in connection with the tests of transport wheels.

* * *

The pest control project was discussed with Frank Irons and his coworkers at Toledo, Ohio. Attention is now being focused on the development of a satisfactory, low-cost grasshopper bait distributor, and the publication of plans. The machine as now constructed appears to have much promise and its use in numbers should materially aid in the control of this pest. Work on corn borer equipment will be resumed in the spring.

* * *

The annual meeting of the National Joint Committee on Fertilizer Application was held in Washington, D. C., November 14. G. A. Cumings briefly discussed the desirability of expanding the activities of the committee in view of the nation-wide interest in fertilizer placement research and machinery developments. The committee approved the appointment of six subcommittees covering fertilizer placement research according to four geographical areas of the country, fundamental factors and machinery improvements. Under the direction of W. H. Redit and L. G. Schoenleber a number of state cooperators inspected the Bureau's fertilizer machinery laboratory and experimental equipment at the Arlington Experiment Farm.

* * *

At the autumn meeting of the Utah Academy of Sciences, Arts and Letters, held at Provo, Utah, November 5, E. M. Dieffenbach gave a talk on "Weed Machinery," illustrating it with colored slides.

* * *

I. F. Reed visited the North Alabama Experimental Station November 8 and 9 to arrange for experimental fields for cotton and seedbed preparation studies.

# Student Branch News

### GEORGIA

GEORGIA'S Student Branch of the American Society of Agricultural Engineers held its regular meeting Monday evening, October 24, in its club room.

The program for the evening was the initiation of twenty-two new members. Five of the new members made one minute talks on the subjects (1) how to turn out a light, (2) how to screw a nut on a bolt, (3) how to operate a paper weight, (4) how to read a calendar, and (5) how to open a drawer.

The Branch held its next regular meeting Monday evening, November 7, in the club room. The managing editor of the "Agriculturist" and the editor of the "Georgia Ag Engineer" urged members of the club to cooperate by writing articles for these publications. The club voted to sponsor a dance this quarter; the date to be announced later.

The program for the evening was a trip, via an illustrated lecture, to the annual meeting of the American Society of Agricultural Engineers at Asilomar, California. On this trip we traveled 8,000 miles and visited, in addition to the meeting, the Grand Canyon, Boulder Dam, Los Angeles, Hollywood, San Francisco, the Golden Gate Bridge, Alcatraz, the University of California at Berkeley, and Salt Lake City. The pictures and explanation created such evident interest that it seemed as if we actually traveled.

Boulder Dam was one of the most interesting features pictured on the tour. It is approximately 700 feet high and 500 feet thick at the bottom. Its purpose is fourfold, furnishing power to generate electricity, water for irrigation purposes, control of soil erosion, and water supply for cities, some of which are as much as 300 miles away.

After the tour had been completed, Joe Hawkes, the 1938 representative to the A.S.A.E. meeting, who had been conducting the tour, urged the Branch to start work for the Farm Equipment Institute Cup and to make plans to send a large delegation to the annual meeting of the A.S.A.E. to be held in St. Paul, Minnesota, in 1939.

### OHIO

Due to the illness and death of his brother, Cecil Robinson, president-elect of the Ohio State Student Branch, was unable to return to school this fall. By a vote of the members vice-president Gordon Royle was made president and Dwight Warner was elected vice-president. Other officers are Robert Main, secretary, and Harris Gitlin, sergeant-at-arms.

The Branch's annual "Open House", held October 20, was attended by a large number of new students, many of whom have since become members.

Plans for the annual Farmers' Week lunch counter sponsored by the Branch are already under way.—*James G. Lye, chairman, publications committee.*

### WISCONSIN

The Wisconsin Student Branch shows promise of being even more active this year than it has been in the past. The officers for this year are Richard Ranny, president; Homer Witzel, vice-president; Reuben Retz, secretary and treasurer; representative on the agricultural student council, Richard Witz; and reporter, Merlin Goehring.

Several members worked with the local department on an exhibit for the Wisconsin Implement Dealer's Convention, held in Milwaukee November 8, 9, and 10. A demonstration in connection with a new cultipacker having a grass-seeding attachment, which is in the experimental stage of development, was the feature project for this demonstration.

This year a speaking contest among local student branch members will be sponsored. Prizes will be awarded the winners. The contest is designed to offer members an opportunity to develop their ability to speak before a group, and will result in active members taking part in our programs. Our program chairman, Homer Witzel, is procuring speakers to supplement our member's contributions to the meetings.

For the first time in several years an entry in the F.E.I. contest will be made. Members are enthusiastic about this activity.

A social committee is active in planning a party to be held at the Memorial Union on November 12. The parties last year were successful and indications are that the coming event will supercede anything attempted in the past. The purpose of these parties is to increase good fellowship among the members.—*Merlin Goehring, Reporter.*

## Applicants for Membership

**The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the November issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.**

*D. K. Bullens,* president, New England Auto Products Corporation, Pottstown, Pa.

*Eugene Henry Graugnard,* overseer and maintenance man, F. A. Graugnard and Son, St. James, La.

*R. C. Hines, Jr.,* assistant county agent, Mechlenburg County, Virginia. (Mail) Wakefield, Va.

*Norton Ives,* research fellow, agricultural engineering department, Iowa State College, Ames, Iowa.

*W. S. Lockwood,* director, Crude Rubber Development Bureau, 820 Munsey Building, Washington, D. C.

*J. W. Martin,* research fellow, department of agricultural engineering, Iowa State College, Ames, Iowa. (Mail) 525 Welch Avenue.

*George M. Petersen,* special research assistant, agricultural engineering department, University of Illinois, Urbana, Ill.

*Max L. Rysdon,* vice-president, Sioux Steel Company, Sioux Falls, S. D. (Mail) Box 898.

*J. A. Vorster,* graduate student, Iowa State College, Iowa State College, Ames, Iowa. (Mail) 238 North Hyland Avenue.

TRANSFER

*J. W. Slosser,* associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 465, Guthrie, Okla. (Junior Member to Member)

# Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted may be addressed to the publisher thereof or to AGRICULTURAL ENGINEERING

PLACEMENT OF FERTILIZER FOR COTTON, *E. R. Collins, H. B. Mann, and G. A. Cumings.* North Carolina Sta. Bul. 318 (1938), pp. 38, figs. 16. The results of studies conducted by the station in cooperation with the USDA Bureau of Agricultural Engineering, the National Fertilizer Association, and the National Joint Committee on Fertilizer Application are reported.

A study of fertilizer placement for cotton was conducted on Norfolk sandy loam near Rocky Mount, N. C., during the period of 1931 to 1935, inclusive. A standard 4-8-4 fertilizer was used in the major part of the work, but an 8-16-8 mixture was also applied for certain treatments in the earlier experiments.

On flat prepared seedbeds, fertilizers placed either in a 1¾ or 3½ in band at distances of 1, 2, 3, and 4 in directly under the seed at time of planting delayed germination and reduced the stand of plants. These adverse effects were severe at the 1-in depth and progressively became less marked at the deeper placements. Mixing of the fertilizer throughout the soil zone 3½ in wide and 3 in in depth, located under the seed, retarded germination and reduced the stand of plants particularly under the less favorable moisture conditions. Reduced yields for these treatments corresponded closely with the early adverse effects. On flat prepared seedbeds, fertilizer placed at time of planting in a narrow band at each side of the row in a zone ranging from 1½ to 3½ in laterally from the seed and from 1 to 3 in below seed level resulted in the most rapid germination and seedling growth as well as the highest yields of seed cotton. A band of fertilizer at only one side of the row gave similar results. With a side placement there was no advantage in applying a small amount of the fertilizer either in the furrow with the seed or in the surface soil above the seed.

Tests included only in the 1934 and 1935 experiments gave the highest yields of seed cotton when the land was bedded 2 weeks before planting and the fertilizer was applied at time of planting in a band 2½ in to each side of the row 3 in below seed level. Planting the seed in firm moist soil was evidently one of the factors which favored this method.

Bedding on the fertilizer about 2 weeks before planting the seed gave best results when the fertilizer was applied in a band 2½ in to each side of the row compared to either a band centered on the row or mixing the fertilizer with the soil in the row. However, the advance-of-planting applications, as commonly made, were somewhat inferior to applying the fertilizer at time of planting in a band at each side of the row.

Side placement of fertilizer at 400, 800, and 1,200 lb per acre of 4-8-4 mixture and at equivalent rates of 8-16-8 fertilizer on the average gave more rapid germination and a higher yield than did under-seed placements. The yield differences between fertilizer placements were much more pronounced at the higher fertilizer rates than at the low rate.

When the initial fertilizer application was made at time of planting in a band at each side of the row, withholding and side dressing one-half of the mixture at time of thinning definitely reduced the yields, but withholding and side dressing one-half of the nitrogen appeared to be of slight advantage. Similar treatments with the initial application placed in a band directly under the seed were inferior to the side-placement group.

Under the conditions of this study most rapid germination of seed and growth of plants and the earliest maturing cotton and highest yields were obtained by placement of the fertilizer in a narrow band at each side of the row, irrespective of the amount of fertilizer or time of application. There is some indication that planting the seed in firm moist soil as is usually assured by forming raised beds several days in advance and then placing the fertilizer at time of planting in a narrow band 2½ in to each side of the row, from 2 to 3 in below seed level, was the most advantageous method used.

THE RATE OF INFILTRATION OF WATER IN IRRIGATION PRACTICE, *M. R. Lewis.* Amer. Geophys. Union Trans., 18 (1937), pt. 2, pp. 361-368, figs. 8. The data reported in this paper were secured in the course of irrigation and drainage investigations conducted during 1926 and 1927 by the Idaho Experiment Station and since 1932 by the Oregon Experiment Station, both in cooperation with the U.S.D.A. Bureau of Agricultural Engineering.

Tests of the rate of infiltration of irrigation water on several different soils at different locations in Idaho and Oregon are reported in which small cylinders 18 in in diameter were used. This equipment was found to give reliable results.

Depths infiltrated ranged from 0.48 to 20 in at the end of 1 hr and from 0.53 to 80 in at the end of 5 hr. The more rapid infiltration at the beginning of an irrigation should be considered in the design of irrigation field layouts.

VEGETABLE GROWTH AS AFFECTED BY LOCATION OF HEAT CABLE IN HOTBEDS.—A PROGRESS REPORT, *H. N. Colby and E. F. Burk.* In a Progress Report on the Investigation of the Various Uses of Electricity on the Farms of Washington for the Year 1937, L. J. Smith, H. N. Colby, and H. L. Garver. [Pullman]; Wash. Com. Relat. Elect. Agr., 1937, pp. 20-30. Investigations conducted by the Washington Experiment Station in cooperation with the Washington Committee on the Relation of Electricity to Agriculture are reported.

Four 6x6-ft hotbeds were used, heat being supplied by hotbed cable placed at several depths in the soil and above ground approximately as follows: (1) Suspended in air several inches above growing vegetables, (2) on surface of the soil, (3) 11 in below soil surface, and (4) 4 in below soil surface. Vegetables representing the several types started in hotbeds for transplanting were grown under each condition and detailed observations made of the root and top growth of each kind as related to the position of the heating cable. These included radishes, cabbage, tomatoes, peppers, cucumbers, melons, lima beans, celery, lettuce, and New Zealand spinach.

The most noticeable result was that all vegetables in bed No. 2, where the cable was laid on the surface of the soil, came up first and gave the best growth. This was true for both runs. The average weekly soil temperature was the highest in this bed. The next highest average soil temperature occurred in bed No. 1 in which the next best final growth occurred. While the seeds did not germinate as quickly as in bed No. 2, the plants in bed No. 1 grew more rapidly as soon as they got up to where the heat could reach them. The general characteristics of the plants grown in bed No. 1 were tall, rather spindly stalks, with radishes and lettuce sending out seed stalks earlier in their development than in bed No. 2. This appeared to be due to the higher air temperature. There was little difference in rate of germination or growth in beds Nos. 3 and 4.

The root systems were for the most part in proportion to the size of the plant above ground. The warm-season plants in bed No. 2 all had strikingly longer roots than the other beds. The cool-season plants did not show much difference in length.

It is considered evident that for all factors concerned, with the exception of energy consumption, the location of the cable in the soil surface as in bed No. 2 is the most satisfactory. However, it is believed that the same results may be obtained with a lower energy consumption by pressing the cable down until it is buried under 0.25 in of soil.

GRAIN STORAGE INVESTIGATIONS BY THE MARYLAND STATION, *R. W. Carpenter.* Maryland Sta. Rpt. 1937, pp. XVII, XVIII. The progress results are briefly presented of studies cooperative with the U.S.D.A. Bureau of Agricultural Engineering on grain storage on the farm. These show that wheat harvested and threshed with a moisture content of 16 per cent or more cannot be safely stored in any known form or type of bin without first being treated; bin insolation retarded heating but did not prevent spoiling of wheat containing 16.5 per cent moisture; ventilation is of value in the retarding of heating by permitting greater heat dissipation, and in removing moisture, though once the wheat has gone out of condition ventilation loses value rapidly; and that use of absorptives as a drying agent has considerable promise, but their practical application is yet to be proved. *(Continued on page 548)*

# Agricultural Engineering Digest

*(Continued from page 546)*

SOME KINEMATIC AND DYNAMIC STUDIES OF RIGID TRANSPORT WHEELS FOR AGRICULTURAL EQUIPMENT, *E. G. McKibben.* Iowa Sta. Res. Bul. 231 (1938), pp. 321-390, figs. 43. Field and laboratory studies relating to the consideration of rigid right-cylindrical transport wheels with the purpose of elucidating the motion and force relations of the soil upon which they operate are reported.

Equations were developed for the relative effect of speed, diameter, and effective obstruction height on impact. The mechanics of a wheel rolling on a nonelastice friable medium was developed and the fact of slippage established both rationally and experimentally. The nature of the soil motions and soil displacements caused by a rigid wheel was studied. It was found that the soil adjacent to the track left by a rigid wheel is moved ahead and that this change in position of soil particles is attained by curved rather than straight line motion.

The effect of area upon the supporting capacity per unit area was studied for four conditions. A wide variation was found for this relationship. Apparently this variation was caused by differences in the cohesion and internal friction of the soils.

An apparatus for studying the rolling resistance and slippage of individual transport wheels was designed and built. With this apparatus the possibility of using variable load trials was studied. The results obtained by the use of this method were unreliable. The effect of speed was investigated for two conditions, meadow and tilled soil. For these soil conditions and speeds up to 5 miles per hour, the effect of speed appeared to be of minor importance compared to the effects of diameter and width. The effect of repeated trials in the same track was investigated, and the rolling resistance was found to vary approximately as the –0.2 power of the number of the trial for trials on meadow and as the –0.5 power on tilled soil.

The effects of load (300 to 1,200 lb), diameter (16 to 60 in), and width (2.5 to 20 in) on rolling resistance and slippage were investigated for three surfaces—meadow, tilled soil, and a layer of dry, loose sand on concrete. The rolling resistance was found to vary approximately as the 0.6 to 1.3 power of the load, the –0.5 to –0.7 power of the diameter, and the –0.5 to 0.5 power of the width. These variations are explained qualitatively by certain combinations of wheel dimensions and soil conditions.

The association of soil moisture, volume weight, and resistance to penetration with rolling resistance was studied. A very high positive correlation, 0.97, was obtained between penetration readings of the "penetrometer" used in these studies and rolling resistance, and a high negative correlation, –0.87, was obtained between volume weight and rolling resistance.

The general conclusion is drawn that the impact resulting when a rigid wheel strikes a solid obstruction is (1) proportional to the square of the speed $S$, (2) increased by increasing the effective height $b$ of the obstruction or by decreasing the radius $r$ of the wheel, (3) a function of the ratio $R$ of the wheel radius $r$ to the effective height of the obstruction $b$, (4) a function of the angle $\theta$ between the vertical radius, $O$ to $Q$, and the radius, $O$ to $P$, striking the obstruction, (5) proportional to the product of the secant and the square of the tangent of the angle $\theta$, (6) approximately proportional to the square of the tangent of $\theta$ for small values of the angle $\theta$ and the corresponding large values of the ratio $R$, and (7) of the same order as the impact which would result by falling from a height, $H$, where

$$H = \frac{0.0334\, S^2 R\,(2R - 1)}{(R - 1)^3} = 0.0334 S^2 \tan^2\theta \sec\theta$$

The mechanics which have been developed for the rolling of a rigid wheel on an elastic surface cannot be applied to such a wheel when rolled on a nonelastic friable medium. During one revolution a rigid wheel rolling on a nonelastic friable medium will travel a distance greater than the length of its circumference. The rolling of a rigid transport wheel causes a permanent soil displacement parallel to the direction of its travel. The change in position of soil particles caused by the passage of a rigid transport wheel is attained by curved rather than straight line motion. One-hundred-ft variable load trials are unreliable for the study of the effect of load upon the rolling resistance of rigid transport wheels because of the time lag between the application of a given load and the attainment of equilibrium penetration with its corresponding rolling resistance.

For the range of areas tried (approximately 3 to 12 sq in) increasing the supporting area increases the supporting capacity per unit area for cohesionless soils and decreases it for soils with cohesion. For soils of intermediate characteristics there is some evidence that this relationship passes through a minimum with the lowest supporting value per unit area occurring at some intermediate area.

It is concluded further that the factors contributing to rolling resistance are (1) friction in the axle bearing, (2) forward, lateral, and downward displacement of the soil, (3) friction between the soil and the face and edges of the rim, (4) adhesion of soil to the wheel, and (5) impact of wheel upon surface irregularities.

Within the range of usual operating conditions the effect of changes in wheel load, diameter, and width can usually be approximated by a simple exponential equation of the form $Y = KX^c$, where $Y$ is the rolling resistance, $X$ is the load, diameter, or width, $K$ is a constant depending upon the soil and wheel conditions and the units of measurement used, and $c$ is a constant depending upon soil and wheel conditions but independent of the units of measurement. For this investigation the values of $c$ were of the order of 0.6 to 1.3 for the effects of load, –0.5 to –0.7 for the effects of diameter, and –0.5 to 0.5 for the effects of width.

STAGES AND FLOOD DISCHARGES OF THE CONNECTICUT RIVER AT HARTFORD, CONNECTICUT, *H. B. Kinnison, L. F. Conover, and B. L. Bigwood.* U. S. Geol. Survey, Water-Supply Paper 836-A (1938), pp. II + 18, pl. 1, figs. 2. This report relates particularly to the flood of 1936, but gives comparative information regarding previous floods covering a period of nearly 300 yr.

MODERN METHODS IN ELECTRIC BROODING, *J. C. Scott.* Rural Electrif. Exch., n. ser., 1 (1938), No. 1, pp. 1-4, figs. 4. These methods are described briefly and some of the more important equipment, especially that electrically operated, is illustrated.

PRELIMINARY ANALYSES OF THE COOLING OF FRUIT PACKAGES, *G. M. Dreosti.* Union So. Africa Dept. Agr. and Forestry, Rpt. Low Temp. Res. Lab., Capetown, 1933, pp. 52-60, figs. 3. This is a temperature study based upon the physical characteristics of each type of fruit package tested. The preliminary experiments were carried out in the laboratory on a small scale with packages arranged in the simplest type of stack—a single tier of boxes.

The tier consisted of five packages stacked vertically with 4 in of cork insulation on the bottom, top, and ends of the tier. The data on cooling were taken in boxes 2, 3, and 4 as these would be more representative of an infinite stack. The range of cooling in all cases was from 80 to 35 F, as this closely approximates commercial conditions. The air temperature in the chamber was held approximately constant at 15 F throughout the whole of the cooling process, except where otherwise stated. Cooling experiments were varied from no forced movement of air up to air velocities past the sides of the boxes of 800 ft per min, the direction of the air in movement in all cases being vertically downward.

It was found that during rapid cooling of individual fruits in air moving at 800 ft per min, wrapped fruit takes approximately twice as long to cool as naked fruit. When the fruit is packed in a box the wrapped fruit cools almost as rapidly as naked fruit, indicating that the lagging due to wrapping is almost completely eliminated by the greater lagging effect of the package. The fruit at the periphery of the boxes cools at approximately the same rate, but the fruit in the center of the box cools more rapidly in woodwool-lined boxes than in cardboard-lined boxes. The replacement of the corrugated cardboard by a thin sheet of metal such as aluminum foil results in only a slight improvement in the rate of cooling, the effect being greater on the side fruit than on the center fruit.

The application of forced air movement reduces the time of cooling very considerably, the relative reduction being greater in the case of trays than in bushel boxes, and the difference between central and side fruits is also reduced. Although the cooling time of the side fruit may be reduced approximately the same extent by lowering the air temperature as by the application of forced air movement, the latter method is to be preferred on grounds of more even cooling of the fruit. In cooling by still air the temperature difference between central fruit and side fruit in a box of pears is smaller than in the more rapidly cooling trays of peaches and plums.

An air velocity of 100 lin ft per min reduces the cooling time to half compared with air in convective movement only. In order to halve the cooling time at 100 ft per min again it is necessary to increase the air velocity to 400 ft per min.

By lowering the air temperature the cooling time is reduced in approximately the inverse proportion of the increase of the mean temperature difference between fruit and air during the cooling (from 80 to 35 F). The lag of temperature of the center fruit behind that of the fruit at the sides is, however, increased.

Small fruits cool somewhat more rapidly than large fruit without much effect on the temperature gradient in the case where the fruit is packed in nests of woodwool, e. g., peaches. In California boxes of pears where the fruits are in contact with each other, however, the temperature gradients appear to be slightly less for smaller fruit, as expected. *(Continued on page 550)*

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*(Continued from page 548)*

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE IOWA STATION, *H. Giese, J. B. Davidson, E. V. Collins, and H. J. Barre.* Iowa Sta. Rpt. 1937, pt. 1, pp. 48-52, fig. 1. The progress results are briefly reported of investigations on farm building losses due to wind and fire; development of equipment for check-rowing beets; the kinematics and dynamics of transport wheels used on agricultural equipment; the basin method of treating pastures to prevent erosion, runoff, and loss of fertility; atmospheric exposure tests of wire and fencing; utilization of agricultural wastes for farm building insulation; development of a two-way terracing machine; and utilization of plywood and lumber in farm building construction.

ELECTRIC HEAT FOR LAYING HOUSES, *H. Beresford, J. B. Rodgers, and C. E. Lampman.* C.R.E.A. News Letter [Chicago], No. 16 (1937), pp. 18-24, figs. 6. Studies conducted by the Idaho Experiment Station in cooperation with the Idaho Committee on the Relation of Electricity to Agriculture are reported. Two laying houses were used, one a 20x40-ft gable-ceiling insulated house and the other a 20x90-ft gable-roof, straw-loft type of house. These houses were designated as the insulated house and long house, respectively.

The house in which the heating trials were conducted was 20 ft deep. The building was divided into two 20-ft pens with two double windows, two three-light cellar sashes under the droppings boards, and a door in each 20-ft section. The north wall and the two ends of the long house were of double construction. The south wall had but a single thickness of siding nailed to the studding. The long house was originally designed as a straw-loft type of house, but a 2-in layer of planer shavings was placed on the loft floor to insulate the ceiling. The long house was divided into nine 10-ft pens, each pen having a window and a door in the front or south side. The pens were numbered from one to nine, beginning at the west end of the house. Pen No. 5 was the furnace room and housed two underground furnaces, one for heating the west half and the other the east half of the building. The homemade electric heater was used in the insulated house.

It required considerably more electric energy to heat the west half of the long house to approximately the same temperature than it did to heat the insulated house. In other words, the electric energy required to heat the insulated house to the same degree of comfort averaged for the two test periods only 35 per cent of the energy required to heat the uninsulated house. Insulation and better construction no doubt were responsible for a large part of the difference in energy consumption. However, the difference in the characteristics of the heaters is a noteworthy factor. The average daily cost of electric energy at 3 cents per kwh for 2 yr for the east half of the long house was 54.92 cents and for the insulated house 18.98 cents. The cost of fuel for heating the east half of the long house with the underground furnace, coal at $12.50 per ton, averaged 31.6 cents per day for the 2 yr. To the fuel cost of 31.6 cents per day should be added the cost of the attendant's time in firing and caring for the furnace, which will average approximately 20 cents per day (0.5 hr at 40 cents per hour) making a total operating cost of 51.6 cents per day to operate the underground furnace.

The data and observations showed conclusively that electric heat is economically feasible in laying houses that are well built and well insulated. Electric heating is not recommended for poorly built and uninsulated houses, especially if cheap fuel is used. One of the chief advantages of electric heating is that it can be used for stand-by purposes.

The single-wafer type of thermostat was used in this investigation and it was found necessary to polish the breaker points and reset the thermostat at intervals. To eliminate this trouble, it is recommended that a thermostat having sufficient capacity, preferably of the quick make and break type, be used to control the operation of the heaters.

In the opinion of the investigators a heater which circulates a relatively large volume of air with a lower rise in temperature is more desirable than one which circulates less air but raises the air to a higher temperature. The heater should be so designed that the heating coils never become hotter than a very faint red, preferably a black heat. Brief specifications for an electric heater for use in laying-house service, based on results of this investigation, call for a heater having a 1,000 to 1,500-watt heating element equipped with a fan capable of circulating from 200 to 225 cu ft of air per minute, the operation of the heater to be controlled by a suitable thermostat. Such a heater, costing approximately $15, may be used in the laying house and also during the brooding season. A 1,000 to 1,250-watt heater has sufficient capacity to warm the air in an insulated laying house 20x40 ft in plan or in a house having a volume of approximately 5,000 cu ft. As a basis for calculating the number of heaters necessary, allow from 100 to 150 watts for every 500 cu ft of volume.

During the investigation it was found to be not only practical but desirable during extremely cold weather to diminish the quantity of air normally allowed for ventilation in order to conserve heat and electric energy. No bad effects were noted as a result of this system of management.

PERFORMANCE CHARACTERISTICS OF 5 AND 6-FOOT COMBINES, *W. M. Hurst and W. R. Humphries.* (Coop. Ill., Ind., Ohio, and Miss. Expt. Stas.). U. S. Dept. Agr. Circ. 470 (1938), pp. 36, figs. 13. The results of tests on 5 and 6-ft combines conducted by the Bureau of Agricultural Engineering in three Middle Western States and two central Southern States in both small grains and soybeans are reported.

The different makes of small combines upon which tests were made were similar in that pneumatic tires were used, and the threshing and cleaning capacity is larger per foot of cutter-bar width than in other machines, making possible a higher ground speed. In small grain the 5 and 6-ft combines were usually pulled from 0.5 to 1 mph faster than the larger sizes; in soybeans an average of 0.5 mph faster. Several machines of the smaller sizes operated at speeds in excess of 5 mph under favorable conditions in both small grain and soybeans. In general there was no relation between size of machine and grain losses within the scope of the experiments. It was found that in combining wheat in favorable seasons cutter-bar losses for small combines were approximately the same as for the larger ones in harvesting, and the smaller machines were superior to them in threshing. In unfavorable seasons the harvesting loss with small combines was higher and the threshing loss lower than with the larger machines. Cutter-bar losses for the small machines operating in wheat constituted 66 per cent of total machine losses and in oats 21 per cent of the total machine losses. Cutter-bar losses for the 8-ft and larger machines operating in wheat constituted 51 per cent of the total machine losses and in oats 25 per cent of total machine losses. Comparatively high threshing losses in oats emphasizes the importance of careful machine adjustment when threshing lightweight crops.

With soybeans in Illinois in 1935 total losses with the small and large machines were practically the same; in 1936 a lower cutter-bar loss for the larger machines resulted in a difference of over 4 per cent in favor of the large machines. In the Mississippi Delta where soybeans are planted in rows the machines in 1936 were practically as efficient as those operating in Illinois, where soybeans are drilled or broadcast. A swath 95 per cent of the total cutter-bar width was taken by the small machines in harvesting small grain, while with the larger machines the swath ranged from 91 to 94 per cent of the total width. In soybeans in Illinois the effective cutting width was 97 per cent of the cutter-bar length for the small machine and 94 per cent for the 8-ft or larger sizes. In the Mississippi Delta the average was 100 and 96 per cent, respectively, for the small and large sizes. Complete quality analysis of small grain samples in Illinois, 1936, indicated no effect on quality resulting from differences in size of machines. In Ohio, 1936, with 4 of 13 samples of wheat obtained from 5 and 6-ft combines, foreign material was a grading factor; with the larger machines test weight alone accounted for the discounts. Grade analysis of soybeans in Illinois in 1935 favored the larger machines and in Mississippi the smaller machines. Different concave arrangements doubtless accounted for the difference in grades.

PROFITS IN ELECTRIC MILK COOLERS FOR DAIRYMAN, DEALER, AND POWER COMPANY, *P. T. Montfort.* Rural Electrif. Exch., n. ser., 1 (1938), No. 2, pp. 25-28, figs. 4. In a brief contribution from the A. and M. College of Texas the results of service tests of electric milk coolers are presented and discussed.

HAY CURING INVESTIGATIONS BY THE STORRS STATION. Connecticut Storrs Sta. Bul. 221 (1937), pp. 31, 32. The progress results of initial trials to test the influence of spontaneous heat generation in connection with forced air draft in curing hay showed that the elimination of moisture condensation on hay by use of forced ventilation did not prevent moldiness of the hay sufficient to make it unfit for use.

In exploratory trials with heating coils on the principle of direct transference of heat through the stationary hay mass, a box 30x44x30 in was built, with varying amounts of radiation in the bottom. It was discovered that there can be little hope of success in attempting to dry a large mass of hay in storage by applying heat with steam coils at the bottom. *(Continued on page 552)*

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*(Continued from page 550)*

POULTRY HOUSE LIGHTING AND ITS INFLUENCE ON EGG PRODUCTION AND CHICKEN GROWTH, *E. L. Dakan*. Rural Electrif. Exch., n. ser., 1 (1938), No. 1, pp. 13-15. Tests conducted at Ohio State University are briefly described and some of the more important results enumerated.

The conclusion is that the influence of light on egg production is obtained through light absorption rather than through exercise and feed consumption at night.

Tests to determine what particular rays of light stimulate the reproductive system showed that it is the long red rays which stimulate birds to reproductive activity. This action appears to involve the visible red rays of light. Evidence also was obtained that it is better to reflect the lights on the roost than on the floor. It was found that a 10-watt and a 25-watt lamp are too small. A 40-watt lamp produced as good results as a 100-watt lamp. It appears that light does not influence growth but does influence sexual maturity.

Experiments with old hens showed that lights suspended over the mash boxes doubled the egg production.

ENERGY REQUIREMENTS OF SWINE AND ESTIMATES OF HEAT PRODUCTION AND GASEOUS EXCHANGE FOR USE IN PLANNING THE VENTILATION OF HOG HOUSES, *H. H. Mitchell and M. A. R. Kelley*. (Ill. Expt. Sta. and U.S.D.A.). Jour. Agr. Res. [U. S.], 56 (1938), No. 11, pp. 811-829, figs. 2. This paper reports an extension to swine of studies originally conducted with poultry. An analytical study was made of the energy requirements of swine for each of the various animal functions, as revealed by published information, and of an integration of these requirements for application to pigs of any particular age, weight, or condition. In this study the various animal functions were differentiated for separate analysis, the ultimate values established then being applied to any particular animal as needed.

The general procedure was to estimate the energy requirements of swine by factoring out and assessing as accurately as possible all items contributing to energy expenditure or storage. These factors were then integrated for pigs of particular weights and conditions. Estimates of the net availability of the metabolizable energy of feed permitted the conversion of net energy into metabolizable energy values. From the latter, dry-matter requirements were estimated for definite, more or less typical rations. Summation of energy expenditures, via basal metabolism, muscular activity, and heat increment of feed, leads to an estimate of heat production. From this, estimates of the probable output of carbon dioxide and of the usual and maximal output of water vapor have been made. Complete estimates of this kind have been made for growing and fattening gilts and barrows, both according to American and English feeding practice, a pregnant gilt and a pregnant sow, and a lactating sow. Tentative estimates of critical temperatures have been made in each case.

The findings are transposed into the form of basic data suitable to aid in the design of hog-house ventilation systems and illustrations of their application are given.

## EMPLOYMENT BULLETIN

**The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.**

### POSITIONS WANTED

AGRICULTURAL ENGINEER, B. Sc., 1934, Oregon State College. Farm reared, four years experience as engineer with Soil Conservation Service. Desires connection in college or industrial extension, farm machinery or farm management. Single. Age 27 years. PW-296

AGRICULTURAL ENGINEER, for two years charged with the administration and coordination of complete erosion control program for U. S. Soil Conservation Service CCC project in Louisiana. Prior to this, prepared plans, specifications, and cost estimates of Castor Creek watershed gully control project, and supervised project when approved. Served several months with L.S.U. Extension Service. For nine years after completing college was engaged in supervisory capacity constructing large bridges and locks. Prefers work as soil conservation engineer or field work with equipment manufacturer. Can furnish best of references. Will go anywhere. Married, two children. Age 35. PW-298

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